

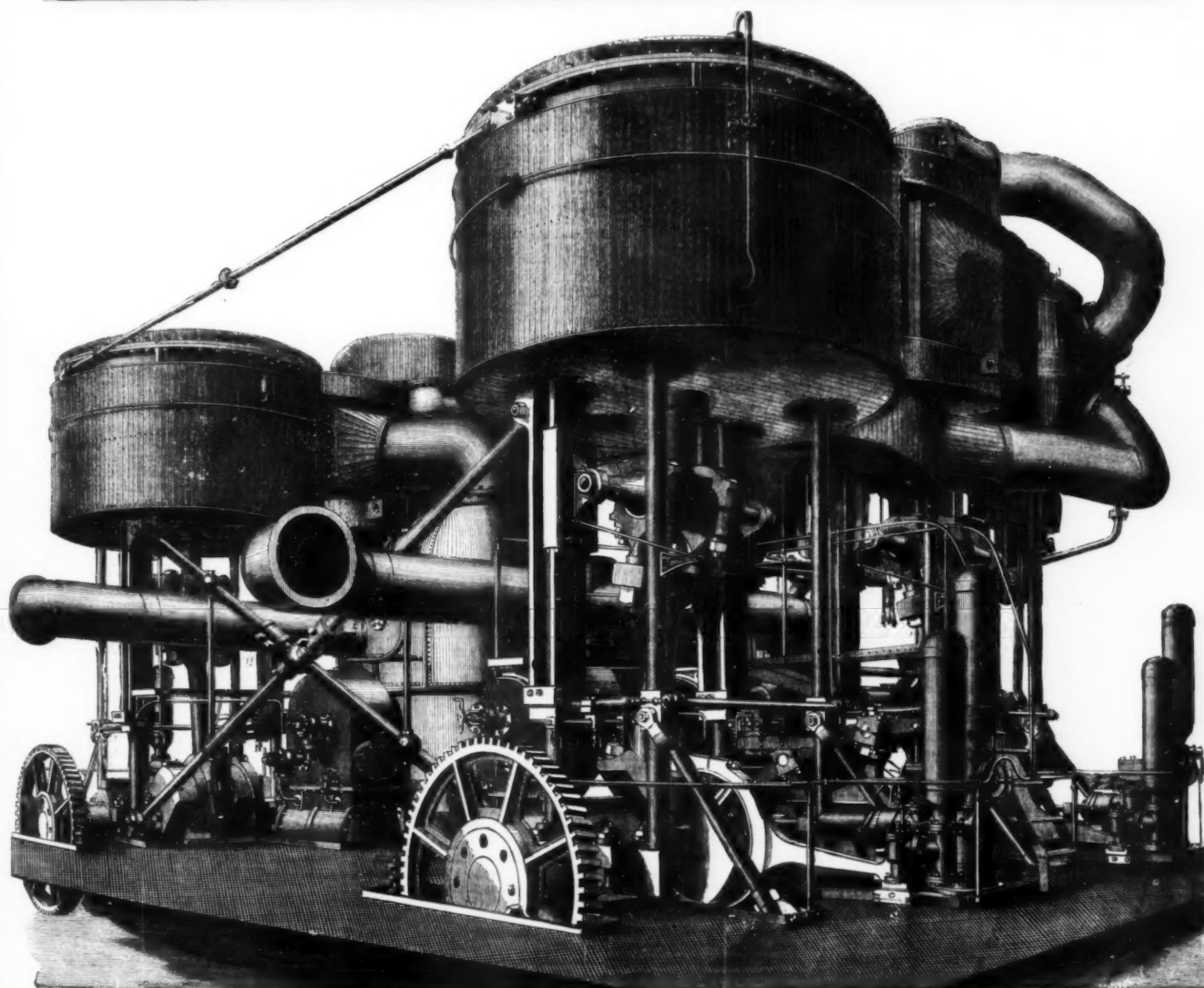
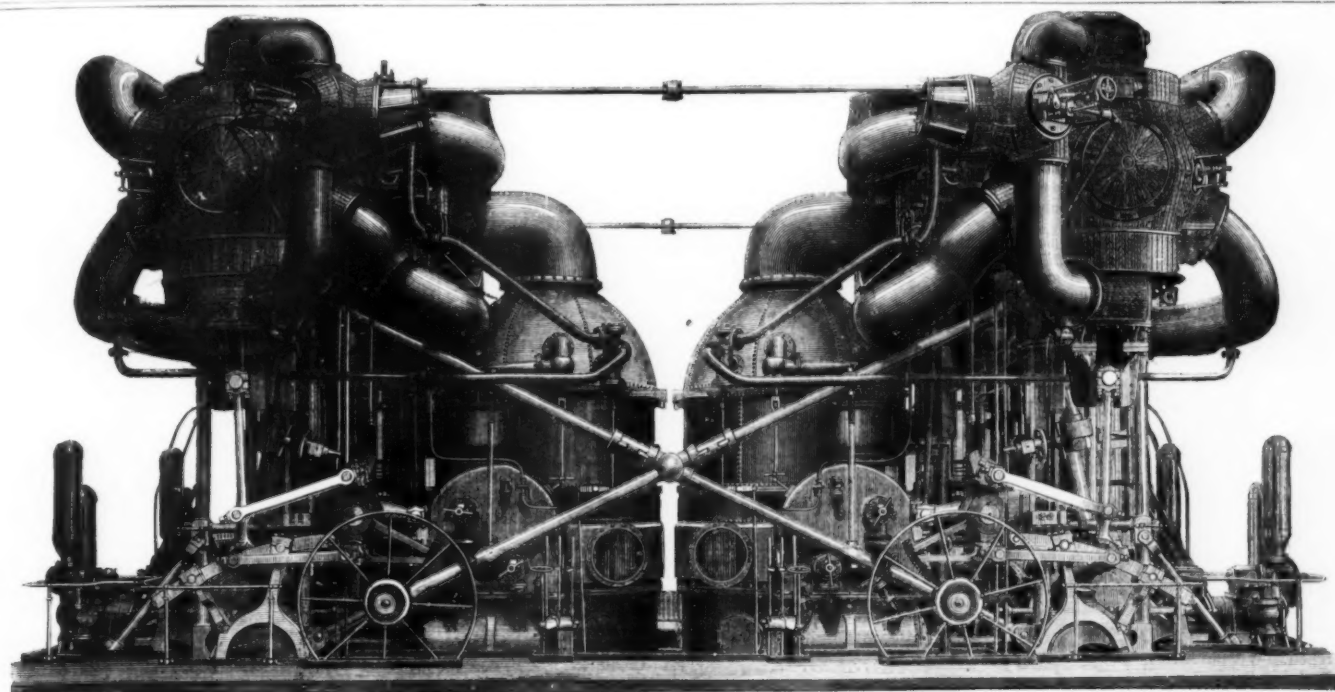
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ENGINES OF H. M. S. NELSON.

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We published a paper read before the Institution of Naval Architects during their recent meeting by Mr. Barnaby, dealing with the Nelson class of ironclads. In both this paper and its discussion an important feature was the attention drawn to the relative performances of the sister vessels Nelson and Northampton, these vessels being of identical dimensions and built on the same lines, but being fitted with different engines and propellers. The Northampton, which was engaged by Messrs. Penn, has engines with three equal-sized cylinders, one of these being the high and the two others low-pressure cylinders when the engines are being worked compound, as is the case when moderate powers only have to be developed, while when working at full power each cylinder is supplied with steam direct from the boilers, the engines being then non-compound. The engines are a first-class piece of workmanship—as might be expected from their makers—but at the trials they have developed but 6,073 horse power, and that only with the use of the blast, the resulting speed of the ship being 13.173 knots. The engines of the Northampton, with water in the boilers, weigh 1,113 tons, and the displacement of the vessel is 7,652 tons, while from some as yet unexplained cause, the ship requires starboard helm to keep her in a straight course, and this interferes with her speed.

The Nelson, on the other hand, has been more successful, her engines, which were designed by Mr. A. C. Kirk, and built by Messrs. J. Elder & Co., weighing 998 tons, and developing on trial 6,624 horse power without the boilers being aided by any steam blast. The displacement of the Nelson is 7,473 tons, or 179 tons more than the Northampton, of which difference 115 tons is due to the less weight of her engines, while she is also free from the defect of requiring the helm to be put over to keep her straight, and it appears probable that the screws with which she is fitted give better results than those of the Northampton. The effects of these differences is that the Nelson has given on her trials a speed of 14 knots against 13.173 knots of the Northampton, an important difference especially when it is considered that the higher speed is attained without the use of the steam blast.

The engines of the Nelson are of the compound intermediate receiver type, and they are worked compound at all powers, it being held by Mr. Kirk that it was especially important to retain the compound system at the high powers so as to keep the quantity of steam required as moderate as possible, and thus reduce the demands upon the boilers. The results obtained with the Nelson's engines have fully indorsed the correctness of these views, and it was stated by Mr. Kirk during the discussion on Mr. Barnaby's paper, that at full power, the coal consumption of the Nelson was but two-thirds that of the Northampton.

In inviting tenders for the machinery of the Nelson and Northampton, the Admiralty directed special attention to the attainment of the required power with as little weight as possible, and it was to meet the requirements of the authorities in this respect that the engines of the Nelson were specially designed. We publish on the preceding page an engraving containing two perspective views of the Nelson's engines, and from these views it will be seen that the design is marked by many special features of interest.

Thus in the first place the engines are without the usual cast-iron framing. The plummer-blocks for the crankshaft are forgings fixed down to strong bearers which extend across the vessel above the inner skin of the double bottom, these bearers being directly supported by the frames between the two skins. Each cylinder is supported upon four wrought-iron columns which connect it to the plummer-blocks, two of these columns carrying the crosshead guides as shown. As will be seen from the lower view in our engraving the pair of columns carrying the crosshead guides are connected at about the level of the lower ends of the latter with the other pair belonging to the same cylinder, while the latter pair of columns are braced by short diagonal stays led from them to the engine bearers. To give the necessary lateral stability to the engine, the cylinders of the starboard engine are connected to the plummer-blocks of the port engine and vice versa by strong diagonal stays, the arrangement of which is shown plainly by the lower figure on our two-page engraving. These diagonal stays pass with a water-tight joint through the fore-and-aft bulkhead dividing the two pairs of engines. In our engravings, which have been prepared from photographs of the engines taken in the workshops, this bulkhead is not shown. Besides these transverse diagonal stays there are also fore-and-aft stays (not shown in our engravings) which support the engines from the adjacent bulkheads and keep them steady during running.

The high and low pressure cylinders are steam-jacketed all over, and their diameters are 60 inches and 104 inches respectively, while the stroke is three feet six inches. The intermediate chambers are separate castings. There are no expansion valves, and the distribution of the steam is effected by piston valves worked by an arrangement of link motion. There is one piston valve to the high-pressure cylinder of each engine, while the low-pressure cylinder is fitted with two piston valves, placed as shown in our engravings. The link motion has very short eccentric rods coupled to a link of large radius, which is in its turn connected to the valve spindle by a radius rod. The motion is, in fact, of the Allan straight link type, but with such proportions that the expansion link, instead of being quite straight as in Allan's gear, is a segment of a circle of large radius. The reversal of the engines is effected by a direct-acting steam cylinder, the movement being controlled by a piston working in a cataract cylinder containing oil. The connecting rods, piston rods, and crankshafts are of iron, and are all of as full strength as in a merchant steamer. The bearing surfaces are also amply large throughout. At their upper ends the connecting rods, it will be noticed, have the fork formed of two short independent pieces connected to a T end formed on the main part of the rod.

The surface condensers, which contain vertical tubes around which the water circulates, have their bodies made of rolled brass, while the domed tops, which allow the steam to expand and distribute itself fairly among the tubes, are of wrought iron. The arrangement of the condensers and exhaust pipes will be seen from our engravings. The air-pump of each engine is of brass, and is placed horizontally, it being worked by an eccentric fixed on one of the arms of the low-pressure crank; this eccentric also working the feed and bilge pumps. The arrangement will be seen from the lower view of our engraving.

The condensing water is forced through the condensers by a centrifugal pump worked by an auxiliary engine. This pump is right at the bottom of the ship, the pump spindle being vertical, and extending up to above the level of the water line. The auxiliary engine is made to drive direct on to the pump spindle. The pump also is arranged

to pump either from the sea or from the bilge, the valve placing it in communication with the latter having its spindle carried up to a considerable height above the bottom of the ship. This arrangement, first introduced in the Inflexible, has been adopted in order that the pumping out of the ship may be carried on until the compartment is quite full of water, whereas the ordinary centrifugal pumping engine placed low in the engine-room gets soon drowned out. Besides, with the pump placed almost in the bilges as is the case in the Nelson, it will commence to draw as soon as there is any water in the ship, so that no time is lost in charging it.

The engines drive screws of the Mangin type, but with the two sets of blades placed at right angles to each other instead of directly behind each other as in the regular Mangin screw. The diameter of the screws is 17 feet 10 inches, and the mean pitch 19 feet 6½ inches.

The two pairs of engines are separated from each other by the longitudinal bulkhead to which reference has been already made, this bulkhead extending through the boiler room. In connection with the transverse bulkheads, this longitudinal bulkhead makes six water-tight compartments, two of which contain the engines, while the four others are occupied by the boilers. In the event of any one of these compartments being flooded steam can be cut off from it, while if it is a boiler compartment which is so flooded, provision is made for leading steam past it without the steam pipes being cooled by contact with water. The stop valves are all arranged to be worked from the deck if necessary. The boilers of the Nelson are ten in number, and are of the ordinary high-pressure type arranged to work at 65 lb. pressure. The grate surface is 608 square feet, and the heating surface 17,500 square feet. The cost of the machinery for the Nelson, according to the navy estimates for last year, was £83,530.

In February last some trials of the Nelson were made at the measured mile at Stokes Bay, the vessel at the time drawing 24 feet forward and 25 feet aft, and carrying 60 tons of trial coal, 546 tons of ordinary coal, and 350 tons of water ballast. The sea was smooth, but there was a brisk breeze from the southwest, the force of the wind being registered as 4. The trials were made at full power, two-thirds power and one-third power, and also using one pair of engines only, the other pair being supposed to be disabled. For four runs made at full power the results were as follows:

Runs.	Time.		Revolutions per Minute.		Speed in Knots.
	Min.	Sec.	Starboard.	Port.	
1.....	4	28	81.71	81.94	13.433
2.....	4	9	81.68	83.85	14.458
3.....	4	20	81.46	82.38	13.846
4.....	4	16	80.85	82.96	14.063
Means....	81.42	82.78	14.050

Mean revolutions of both engines.....	82.1
" pressure in boilers.....	64.5 lb.
" vacuum, starboard engine.....	26 in.
" " port ".....	26.37 in.
" effective pressures in cylinders:	
Starboard, high pressure....	32.75 lb.
" low pressure.....	11.9 lb.
Port, high pressure.....	32.52 lb.
" low ".....	11.15 lb.
Total indicated power.....	6,624 h.p.

The above results were obtained without the use of the steam blast and without water being required on any of the bearings. At two-thirds and one-third power the results were as follows:

	Two-thirds Power.	One-third Power.
Mean pressure in boilers....	58.75 lb.	59.9 lb.
" vacuum, starboard engine.....	27.12 in.	27 in.
" vacuum port engine.....	26.5 in.	26.5 in.
" revolutions.....	71	58
Total indicated power.....	4,126 h.p.	2,323 h.p.
Speed of ship.....	13.86 knots.	10.54 knots.

With the port engine alone working the power indicated was 2,995 horse power, the engine making 75.6 revolutions and a speed of 10.6 knots being obtained, while with the starboard engine working and the port engine stopped, the power developed was 2,904 horse power, the revolutions were 72.25, and the speed of ship 10.1 knots. During these latter trials the helm had to be kept over from 15 degrees to 17 degrees to maintain the vessel in a straight course.

Altogether the engines of the Nelson have given highly satisfactory results, and both Mr. Kirk and Messrs. Elder are to be congratulated upon their performance.—*Engineering.*

BRITISH GUN TESTS.

As Mr. Hotchkiss, the inventor of the machine gun of that name, desired to have some new chilled cast-iron shells with butt fuze tested, the competitive trials between the Nordenfeli 1-inch gun and the Hotchkiss 1½-inch revolving cannon were lately continued at Portsmouth, Eng. The new shell was found to give better results than the inventor's ordinary shell, the penetration being as good as the Nordenfeli gun, while that of the former shells was much less. The fragments showed considerable work upon the thin bulkheads inside a torpedo boat model, but, as the main object of a gun for use against torpedo boats is to allow the projectiles to retain sufficient energy after penetration to fatally injure the machinery and boilers, the result appears to be best accomplished by solid shot. And it is somewhat remarkable that, as regards solid shot, the 1½-inch Hotchkiss steel projectiles, 17 oz. in weight, gave only slightly more penetration than the Nordenfeli 1-inch projectile, weighing 7½ oz. Some trials were subsequently carried out with the object of testing the correctness of previous results as regards accuracy and rapidity of fire; the effect being to confirm the superiority of the Nordenfeli. When firing for accuracy, slowly and deliberately, the mean deviation required for the Hotchkiss at a range of 800 yards was found to be 9 inches, against 5½ inches on the part of the Nordenfeli gun. Tested for accuracy, combined with rapidity, in spurts of five and ten seconds, the revolving cannon fired 23 shots in twenty seconds and scored 8 hits, while the rival gun fired 88 shots in the same time and made 44 hits. Not only were the rapidity and accuracy and the percentage of the one to the other in favor of the Admiralty gun, but also

the absolute accuracy, the mean deviation of the Hotchkiss in the 8 hits being 38½ inches, while the deviation of the Nordenfeli in the 44 hits was 16½ inches. The guns were next fired for maximum rapidity with only accuracy enough to hold on the target. In half a minute the Nordenfeli fired 108 shots against 31 by the Hotchkiss. Tested next in firing 100 consecutive shots from each gun, the Nordenfeli completed the rounds in thirty-nine seconds, including time for changing feed cases; while the Hotchkiss, which worked somewhat heavily after the fiftieth round, required five minutes and seventeen seconds to fire the 100 shots. The trials—which are understood to be final—concluded with a remarkable experiment, which is interesting in other respects than in connection with maritime guns. Battering charges, consisting of 30 lb. of pebble powder, were exposed to the fire of the competing guns. As the Hotchkiss fired shells the powder was easily exploded, but the officers present were astonished to notice that the superior velocity of the Nordenfeli steel bullet successfully exploded the powder every time a hit was recorded, notwithstanding that the trials were made with the powder inclosed in a zinc cylinder and in a Clarkson case, as well as being left exposed in a flannel bag. In the previous report of the trial of these guns it was stated that the number of hits in the last run of 500 yards had not been counted at the conclusion of the trial. They have since been counted, and the result is interesting. The Nordenfeli fired 135 rounds in the run and hit the torpedo boat 115 times, while the cannon fired 50 shots, out of which 36 hit. The target was end-on at the time.

MODE OF SUBAQUEOUS EXCAVATION, DRIVING PILES, OR MAKING SOLID FOUNDATIONS IN QUICKSANDS OR UNSTABLE SOILS.

By CHARLES PONTEZ, Omaha, Nebraska.

In 1832 the subscriber introduced, as patentee, the system of sinking hollow piles by the pneumatic process, the first work being done under his contract for a bridge across the Pee Dee River, South Carolina. In 1854 he originated the water jet for driving piles, as used in the construction of the ocean piers at Long Branch, New Jersey, and Coney Island, New York. In 1854 he made the first use of the water jet at Pungateague, Chesapeake Bay, where he drove a series of iron piles for a lighthouse for the United States Government, under Major Hartman Baché, U. S. Engineers, the iron cylinders to support the structure being thirty-six inches at the base. The next use of the water jet was some years after in England. (See document compiled by L. Y. Schermerhorn, U. S. Corps of Engineers, "Application of the Water Jet for Driving Piles, 1879.")

With this experience he confidently presents to the attention of engineers and contractors the following diagrams, showing some of the applications of a new method of driving hollow piles and making solid foundations in water, in quick or shifting sands, for bridges, wharves, lighthouses, and structures exposed to the wash of the sea or water, and placed at any desired depth, permanent and more economical to construct than by any preceding methods. Wooden piles can be driven and maintained in place in soils which would not otherwise sustain them under a slight charge of current; these are anchored at a depth of many feet into the bottom, affording an economical means of making transit over a multitude of rivers which cannot now be bridged on account of the uncertain security. By the means shown in the diagram circular disks of any desired area up to fifty feet in diameter, composed of a material possessing the requisite inertia, preferably concrete as the most economical and of tried and demonstrated durability, can be sunk either singly or in vertical series. For anchoring wooden piles to sustain bridges or sheet piling, one disk is sunk and one or more piles driven through spaces left for that purpose in the area of the disk, thereby firmly anchoring the piles in place independent of the character of the soil. For piers, bridges, or permanent solid structures, on sinking the first disk others are lowered either during or after the disk has been sunk. There are numerous other applications of the same system it is not necessary to explain here.

Diagram 1.—Figure 1 shows upper surface, aperture, and circular area of foundation disk. Fig. 2 is a vertical section of the same, showing circular base of wood or iron sustaining solid disk of concrete or asphaltum. As shown in diagram it is eight feet in diameter and about twenty inches high, and would weigh over three tons. The center hole serves to receive excavating cylinder through it; the others to receive piles, driven through them into the soil below. The interior of the disk serves to anchor the piles and prevent the action of the current pushing them from the perpendicular, however spongy the soil may be, as shown more fully in Diagram No. 2. Disks up to a diameter of thirty to fifty feet in certain favorable localities could be used, but such disks must be ballasted, and sunk by aid of more than one excavator.

Fig. 3 shows, in section, elevation of sunken disk. The excavating cylinder, B, is formed of sheet iron, connected at its upper extremity with a powerful suction pump or air-tight receiver. The lower section of the excavator is connected with another pump, a force pump, by the hose, C, which passing through the side of the excavating cylinder, then feeds a pipe perforated with a number of small holes. This pipe, leading down near the open end of the cylinder, B, bifurcates and then projects outside the cylinder at opposite sides, forming two external hydraulic excavating jets, D D.

Fig. 3 is a sectional elevation of the excavating cylinder, B, showing internal perforated tube, C, and hydraulic jets, D D.

The operation for sinking a disk is as follows: The excavating cylinder is passed through central aperture, and rests on the mud beneath; the connections are then made respectively with the force pump and suction pump or vacuum chamber. The first effect of the action of the suction pump is to force the nozzle of the excavator, by atmospheric pressure, into the mud for some depth, thereby excluding the outer water. A column of permeable sand or mud now fills the cylinder; under the power of the suction it packs tightly, and the operation would cease, but simultaneously the force pump, G, sends into the column of mud numerous small jets of water; the moment it becomes permeable it passes on in a continuous flow and is delivered by the pump, holding the maximum of solid matter with the minimum of water, or air if forced in instead of water. The hydraulic or air jets external acting over and beyond the area covered by the disk excavates beneath and undermines it, the material passing into the excavator, the disk subsides. Boulders or large stones encountered would be washed into the center of the excavation, where they could be broken through the aperture.

DIAGRAM 1.

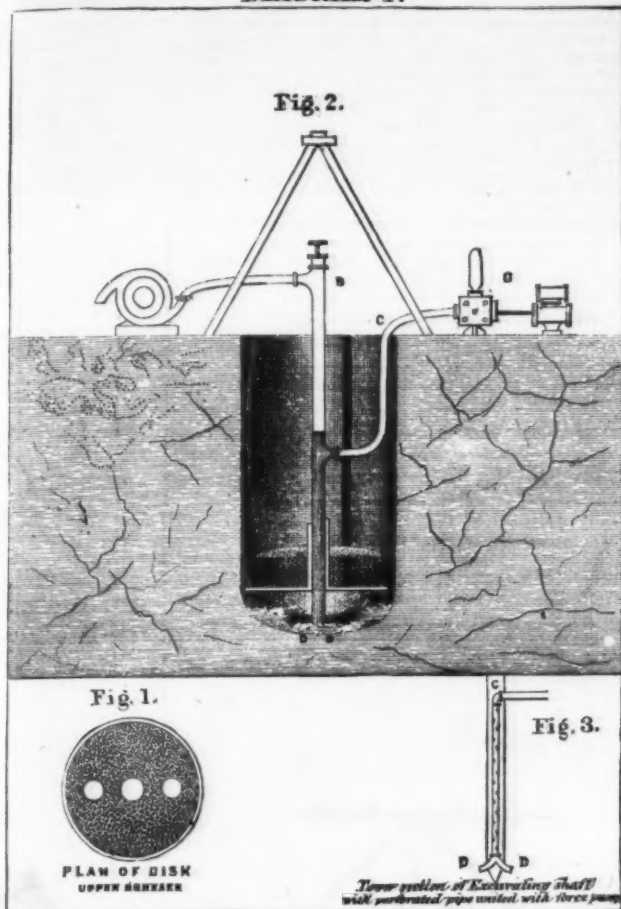


DIAGRAM 3.

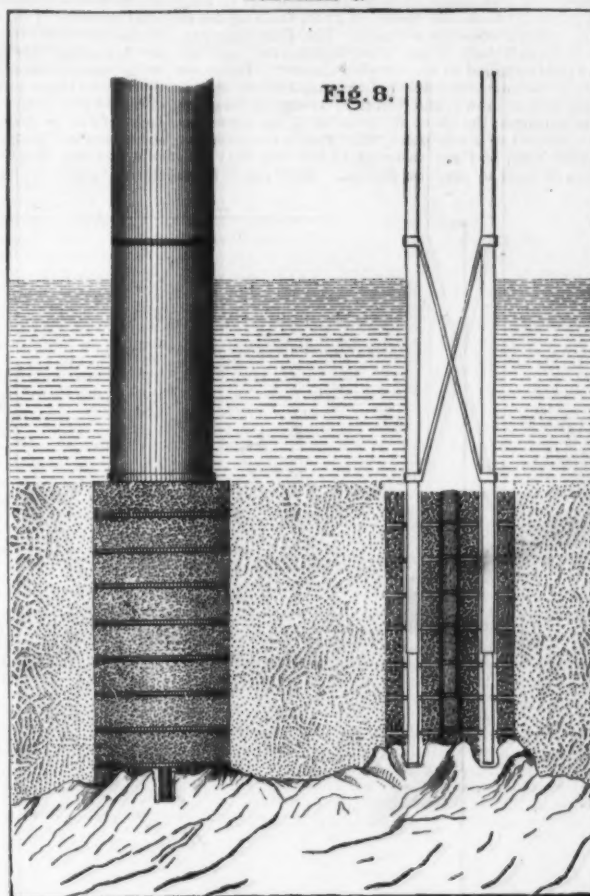


Diagram 2.—Figure 4 shows the method of anchoring wooden or iron piles in unstable bottoms and connecting them in series, to sustain sheeting to prevent the encroachment of the current or the erosion of the banks of rivers, serving the purpose in many localities of rip-rapping or levees. Wooden piles anchored as shown in diagram serve for piers for wooden bridges over quicksand or shifting bottoms, when piles alone will not maintain their perpendicular. Letter H shows a sectional elevation of sunken disk holding two piles. Letter I is an elevation of the same (excavated), showing the excavation made by the disk in sinking filled in with stones, answering the purpose of a rip-rap.

Diagram 3.—Diagram 3 shows the most useful application of the system, for making economically solid deep foundation piers for bridges, lighthouses, beacons, or any structure

him. It was the safest way. Pretty soon Dana came along to collect tickets. Seeing his man, he spoke when he reached him: "Say, my friend, have you the time with you?"

"Yes," said he, as he pulled out a watch, "It is twenty minutes past nine."

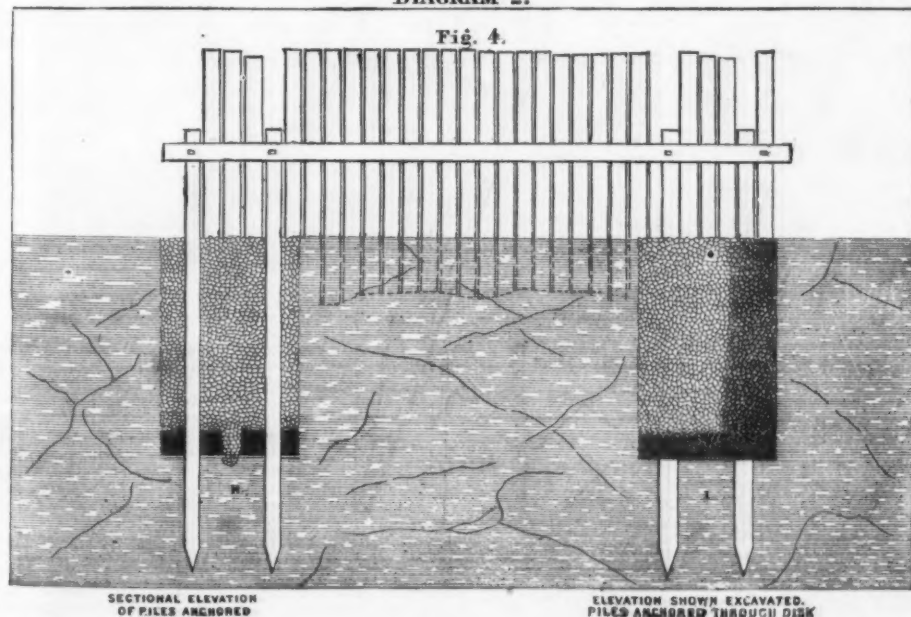
"Oh, it is, is it? Now, if you don't show me your pass, or fare, I will stop the train. There is no railroad man that I ever saw who would say 'twenty minutes past nine.' He would say 'nine-twenty.'"

He settled.—*Patterson (N. J.) Press.*

THE HUDSON RIVER TUNNEL.

At the recent Civil Engineers' Convention, St. Louis, a paper on the "Hudson River Tunnel," by Charles C. Brush, was read by the author. The following is a condensation:

DIAGRAM 2.



subjected to the action of the water or sea. The pier is formed by a series of disks lowered on each other, either during the progress of sinking the first disk or when it has reached rock or a supporting stratum. Figure 8 shows in section a pier for lighthouse or beacon. Single piers of great weight and inertia, a solid mass of concrete or asphaltum, beton, and wood, could be sunk.

THE RAILROAD MAN'S SHIBBOLETH.

DANA KRUM, one of the conductors on the Erie Railroad, was approached before train-time by an unknown man, who spoke to him as if he had known him for years. "I say, Dan," said he, "I have forgotten my pass, and I want to go to Susquehanna; I am a fireman on the road, you know?" But the conductor told him he ought to have a pass with

The Hudson River Tunnel is being constructed by direct application of compressed air, in accordance with the "Haskin" system of tunneling in soft material. There will be two single track tunnels under the Hudson River, each about 18 feet high and 16 feet wide in the clear. The approaches in New York and Jersey City will be a large double track tunnel. The length of the tunnels under the river will be about 5,500 feet, and the land approaches each about 3,000 feet. Soundings have been carefully taken across the river, and the material through which the tunnel is to be driven has been found to be a tenacious silt, which is admirably adapted for this work. A shaft has been sunk on the New Jersey shore near the river line, and the tunnel has been started from the side of this shaft under the river so as to keep at least 20 feet of silt covering over the tunnel at all times. The two-tunnel system under the

river has been adopted because it actually requires less excavation and brick work to construct these two single tunnels than it would one large tunnel of sufficient capacity; besides the enormous advantage of always working a comparatively small heading of 346 square feet, as required in smaller tunnels, over that of 754 square feet, which would be required in the large tunnel.

Work was commenced in November, 1874, but was soon stopped by litigation, which continued until September, 1879. Since that time the work has been steadily progressing. The shaft was sunk by first constructing a wooden "shoe" and building masonry on top of this shoe, as it sank, in consequence of the weight put upon it, the material inside of the shaft being excavated as the shoe sank into the soil; the settlement of the shaft amounted to about one foot per day. November 3, 1879, the shoe was finally in position, and the concrete work in the bottom immediately commenced. This was completed in about thirty-six hours. The average thickness of the concrete was 2 feet 9 inches. An air lock, built of $\frac{3}{4}$ inch wrought iron with $\frac{1}{2}$ inch heads, and doors 3 feet wide and 4 feet high, was then placed in position about half way down the shaft. Air pressure was then put on, and the material excavated sufficiently to build an iron ring 6 feet 4 inches in diameter and 8 feet in length. As soon as this was successfully accomplished, a series of rings were built, united at the top but increasing about 18 inches in diameter for each succeeding ring, thus forming steps descending to the grade of the final tunnel. This temporary work was then lined with concrete, and on February 9, 1880, the first plate was put in position on the most northerly of the permanent tunnels under the river. Since that time the work has been gradually systematized, and it has gone on rapidly and smoothly. During the first week the advance was hardly 1 foot per day, but at present the rate is 4 feet in each twenty-four hours.

The rings in the permanent tunnel are composed of plates of wrought iron, $\frac{3}{4}$ of an inch thick and 2 feet 6 inches wide. There are fourteen plates in each ring; six top plates being 3 feet in length and weighing about 170 pounds each, and the remaining plates 6 feet in length and weighing about 320 pounds each. These weights include the three-inch angle iron that is riveted to the sides and ends of each plate, and the $\frac{3}{4}$ of an inch bolts that bind the plates together. The bricks are hard burned, of the best quality, laid in the best Rosendale cement.

The heading has advanced as follows: The face of the heading is always the exposed silt, which is so stiff when under air pressure that it can be cut in benches as a series of garden terraces, and also into steps rising from one terrace to the other. An average slope of about forty-five degrees is usually left on this face, and the excavation for the building of the rings always commences at the top of the tunnel. Usually five rings are built at the same time, each one of the five rings toward the rear being more nearly completed than the ring directly in front of it. The first four plates in each ring require some slight support, but when the work on the rings has been further advanced the plates are easily held in position by air pressure, the bolting to the adjoining plates and the support received from resting the plates directly on the bed of the silt. The bracing and timber ordinarily used in tunneling are not required on this work.

To DeWitt C. Haskin is due the credit of originating and carrying into successful operation this peculiar system of tunneling.

For engravings and further description of this great work see SUPPLEMENT No. 237.

AN insect called neen, of the *coccus* species, has been discovered in the district of Yucatan, Central America, which is capable of producing a species of India rubber.

AN IRON ROOF OF FORTY-TWO FEET SPAN.

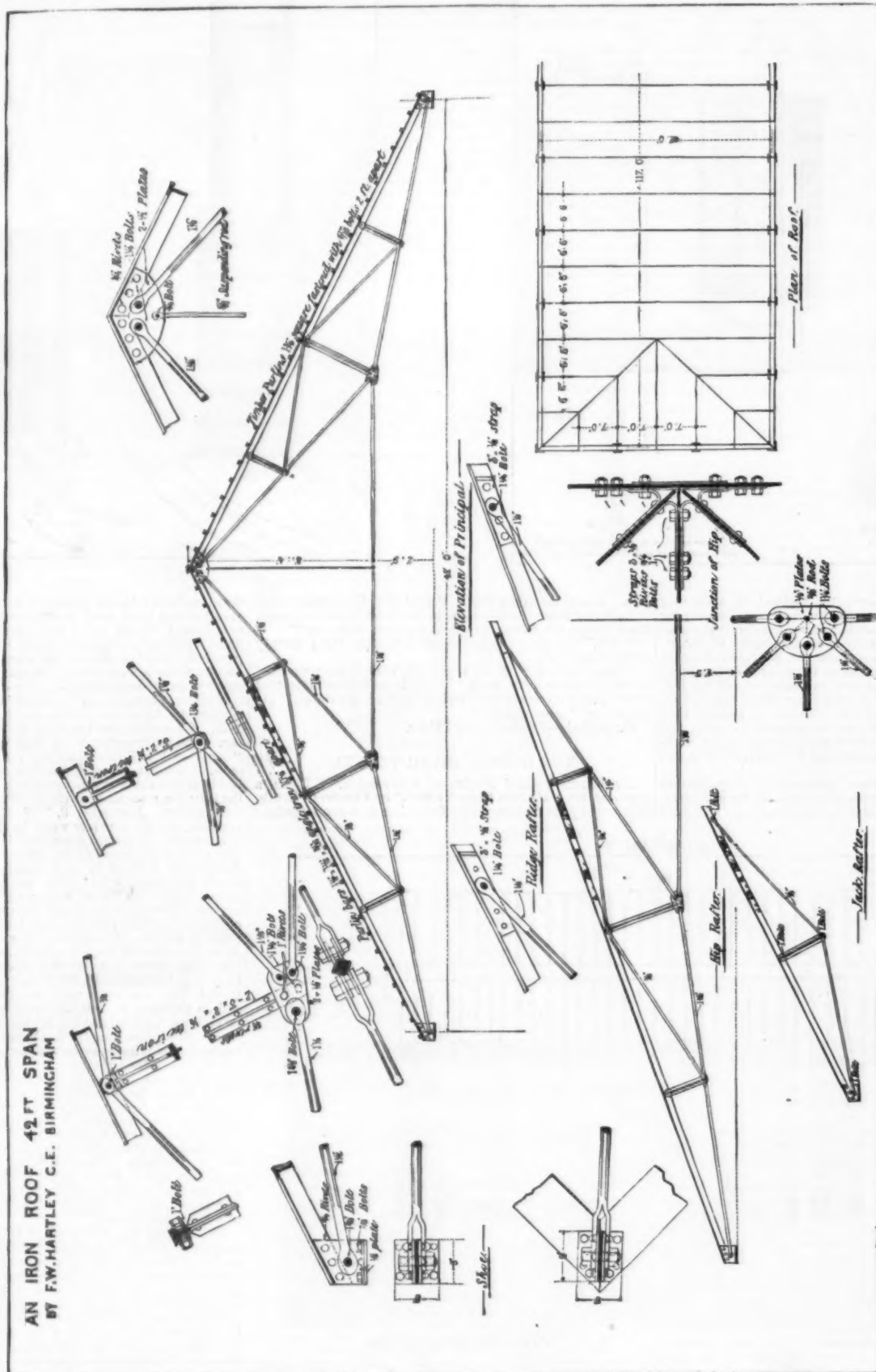
THE above roof is designed to cover a building 117 ft. long and 41 ft. wide between the walls, or 43 ft. from center to center of columns if columns are used. The following particulars will be sufficient to base a specification on, together with the details supplied in the drawings below. There are 13 ordinary principals constructed of tee-iron 3 in. by 3½ in. by ½ in., trussed as shown, and resting in wrought-iron shoes on walls or columns; the shoes are made of ½ in. wrought-iron plates, riveted to a sole-plate with rivets countersunk on the under side, and are fastened to the principal with ¾ in. rivets or bolts as may be desired. Each rafter has a

a horizontal tie formed of 1½ in. iron, with jaws at either end to take junction-plates, to which they are attached with 1½ in. bolts; there is a ¾ in. suspending rod secured to king head-plate by ¾ in. bolt, to take up any sag that may appear in the horizontal tie. The hip principals are of the same section as used for the ordinary principals, and connected in the same manner, of which details are given. When the tie-rods of these hip-principals come together, they are secured by two ½ in. plates as shown, with 1½ in. bolt. The jack rafters are trussed with a ¾ in. rod as shown, and with the secondary jackrafters are 3 in. by 3½ in. by ½ in. tee-iron, having shoes the same as ordinary principals. The slating-laths are placed 10½ in. apart for duchess slates, and

THE LARGE ELECTRIC WORKS OF PARIS.

THE STORES OF THE LOUVRE—THE HIPPODROME.

IF we desire to obtain some idea of the progress made by the electric light during the last few years, we shall have to go down into the sub-cellars under the stores of the Louvre, and also pay a visit to the magnificent electrical works of the Hippodrome. These two great establishments have adopted systems of electrical lighting under special and very different conditions; and, in describing them, we shall show within what limits the electric light, when properly applied and managed, may prove serviceable; and we shall see, too, whether or not it is capable of advantageously re-



AN IRON ROOF 42 FT SPAN
BY F.W. HARTLEY C.E. BIRMINGHAM

So or truss-rod 1½ in. diameter, and one 1½ in. prepared in center with eye to receive ends of counterbrace and struts, which are attached with 1½ in. bolt, and at each end a jaw is formed to clip the 1½ in. junction plates, and also the shoe to which the 1½ in. tie-rod will be secured by 1½ in. bolt, and the 1½ in. rod by 1½ in. bolt, as shown in detail. The struts, 3 to each rafter, are formed of two tee-irons 3 in. by 2 in. by ½ in., riveted back to back with ½ in. rivets and fastened to rafter with 1 in. bolt; the center strut is fastened to junction-plates with 2 1 in. rivets. The counterbraces are formed of ¾ in. round iron with jaw formed at each end for fastening to rafter and junction of truss rods with 1 in. and 1½ in. bolts; the rafters are secured to each other with two king head-plates ½ in. thick, cut to the form shown, and riveted with ¾ in. rivets; they are further tied together with

are fastened to rafters with two ¾ in. rivets; they are afterwards filled in with 1½ in. square Memel battens coated with tar and bedded with thick red-lead paint; they are bolted to slating laths with 5-16 in. bolts, 2 ft. apart, with their heads let in flush with the wood. The weight of one principal complete independent of slating-laths, is about 11 cwt. 3 qr. 0 lb., and the weight per square of 100 ft. covered about 809 lb.; this does not, however, include the weight of slate. — F. R. H. in Building News.

CONSTITUTION OF FROZEN BEECH LEAVES. — By J. SCHROEDER (Bied. Centr., 1879). — The leaves of a beech tree which had been frosted in May appeared to have the same amount of nitrogen and phosphorus as a normal leaf in the same month.

placing the other methods of artificial lighting that are known.

LIGHTING OF THE STORES OF THE LOUVRE.

It is to the stores of the Louvre that belong the honor of having begun the first experiments made with the Jabloch-koff candle. This enterprise, which was modestly begun with a few candles and one Alliance machine, now embraces eighty-four lamps. M. Honoré, the engineer in charge of the establishment, found himself involved at first in many difficulties, but succeeded very ably in overcoming them. It was not convenient, in fact, to locate the boilers, steam engines, and the electrical machines necessary for the production of the electrical current in a sub-cellar and within a very limited space. M. Honoré has adopted the Belle-

ville inexplosive boiler, which answers the purposes required of it very well. Two of these boilers of forty horse-power each supply two Corliss engines. Division Gramme machines are used, three twenty-candle machines and one twenty-four-candle furnishing the current for the eighty-four globes distributed among the stores and the hotel of the Louvre. In this establishment the electric light exhibits all those advantages that are inherent to its very nature—that is, it produces no perceptible heat; it gives out no products injurious to respiration or detrimental to the delicate colors of fabrics; and, finally, it does not affect shades of color, the minutest differences between these being readily perceived. Accidental extinctions of the lights, which, at first, were quite frequent, are becoming more and more rare, and will eventually cease altogether. As to the steadiness of the light, it is much superior to that of the Avenue de l'Opéra, because the apparatus not being exposed to all the variations of the atmosphere are able to work under much better conditions. To sum up, the electric lighting of the Louvre is giving very satisfactory results, a sufficient proof of which is found in the extension that it has successively undergone.

THE LIGHTING OF THE HIPPODROME.

No one can doubt the value of the electric light when there is a question of illuminating large spaces, so in the Hippodrome, with its gigantic dimensions, we find a field of application which taxes it to its utmost. As in the case of the Louvre, the first arrangements made, although they were of quite extensive proportions, were soon found inadequate, and hence it became necessary to begin entirely anew. The accompanying cut represents the new machinery hall. The electric lighting of the Hippodrome includes at present one hundred and twenty Jablockhoff candles and

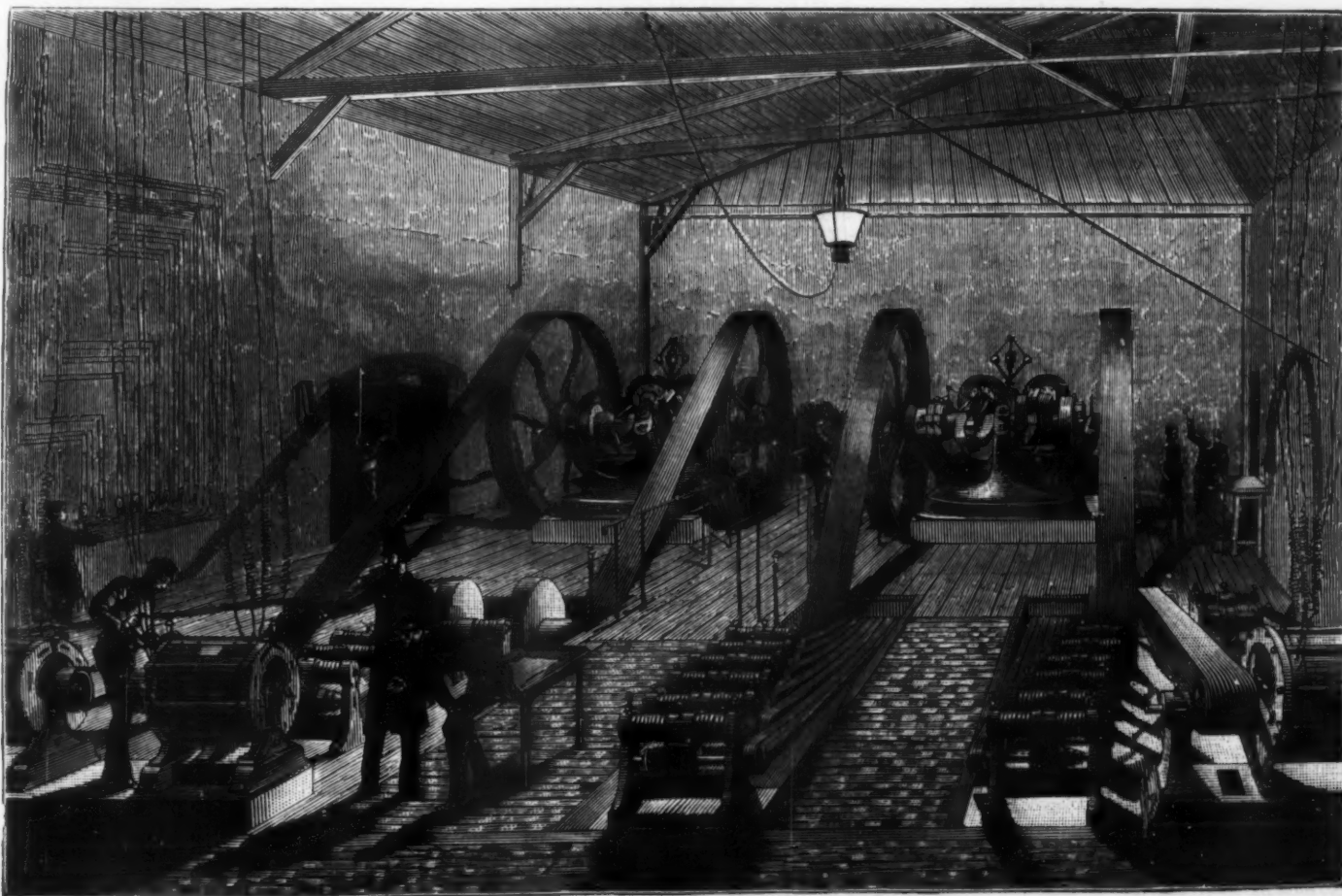
cut, the return being effected through the framework of the building, which being entirely of iron serves as a conductor and completes the circuit.

The engraving shows how motion is communicated to the machines arranged *en escalier*. This arrangement has the advantage of rendering the speed of each machine independent of that of the others, and, consequently, of proportioning it to the distance that separates the lamp from the electric generator. To effect this it is only necessary to properly vary the diameter of the pulley of each machine. The division machines are the alternate current ones of the Gramme system. The coils are arranged in four circuits, each of which supplies five candles. These machines make six hundred and sixty revolutions. Their inductors are supplied by a Gramme machine of the same type as that of the Serrin regulators. These exciting machines make six hundred revolutions per minute. The sixty-candle machine supplies twelve circuits of five candles each, and makes only five hundred and fifty revolutions. While the three twenty-candle machines absorb a power of sixty horses, M. Geoffroy, the engineer-in-chief, estimates that the sixty-candle machine absorbs a power of no more than fifty. Here again is seen the advantage that is presented by the use of powerful rather than small machines. The motive power is furnished by two steam engines of the type styled "compound," of one hundred and twenty horse power each. Two pulleys 2.6 meters in diameter put in motion two intermediate shafts by means of rubber belting 40 centimeters wide. The intermediate shaft carries a drum over which pass the horse-hair belts which put the electric machines in motion. There is no scene more animated and interesting than that presented by these electrical works when everything is in operation and each man at his post. Extinctions, which were so frequent at first, are becoming now rarer and rarer, owing to the care of M. Geoffroy.

ELECTRICAL ABSTRACTS.

INDUCTION MACHINES.

A. TOEPLER.—Static induction machines (like those of Holtz) and dynamo-electric machines are compared together at considerable length, and it is explained how the Holtz machine can produce a small quantity of electricity at a high potential if the prime conductor be insulated, whereas the continuous currents that can be produced are exceedingly small. The author describes a static induction machine which he has constructed somewhat on the principle of putting a number of galvanic cells in parallel circuit. A horizontal axis carries a collection of little circular glass plates at small distances from one another. In alternate spaces between the revolving glass plates are placed well-insulated inductors, and in the spaces which are not filled there is a system of combs with their pointed ends turned in the direction of rotation. The two end glass plates are used as in the Holtz machine to increase the charge in the inductors, while the remainder are employed to cause an electric current to flow into the combs and out through the wire attached to them. Using twenty glass plates, thirteen centimeters in radius, the whole, independently of the rotating mechanism, only occupying 0.06 cubic meter, and making twenty rotations per second, a current strong enough to work a Siemens polarized relay, and twenty times as strong as is obtainable with a Holtz machine, was produced. The best action of the machine was obtained by employing it to charge a battery of Leyden jars, which were being constantly discharged by sparking. Charging eighteen great Leyden jars for 0.6 second, a spark was obtained which could heat five platinum wires. To work the machine continuously required the expenditure of four meter-kilogrammes of work per second, and the efficiency of the arrangement was about one-half. As this amount of work is less



THE LARGE ELECTRIC MACHINE HALL AT THE PARIS HIPPODROME

twenty-one Serrin regulators, which, when all are in operation, require an expenditure of one hundred and twenty horse-power. The electric works of the Palais de l'Industrie will supply three hundred and sixty-five lamps at the opening of the next "salon," but these lamps are distributed in varying numbers among a number of small rooms. At the Hippodrome the hall is lighted by one hundred electric candles and twenty regulators, making the grandest and most powerful illumination that has thus far been effected. The use of two different systems—candles and regulators—necessitates the use of two different styles of machines, both of which were invented by M. Gramme. The one hundred and twenty candles are supplied by three alternate current machines and by one sixty candle machine; the latter (only a part of which can be seen to the right of the engraving) is the largest division machine that has been constructed up to the present time, but differs from the others only in its dimensions and power. The regulators are each supplied by a continuous current Gramme machine. Each continuous current machine can supply only one regulator at a time, but by means of a commutator it is possible to send the current in several directions so as to light up different parts of the hall, according to the requirements of the exhibition taking place. During the chariot races and equestrian performances the regulators around the circumference of the hall are lighted; during performances in the ring the machines supply the regulators that are arranged to light the center; and for aerial performances still another arrangement is adopted. All these changes are effected with remarkable facility and celerity. We must mention one other arrangement which has features of economy about it. The regulator machines have no return wire to complete the cir-

In conclusion, it only remains for us to add a few words on the question of economy, which here plays so great a role.

The electric lighting of the Hippodrome costs, all expenses included, from 250 to 260 francs per evening. To light it by gas a few years ago cost 1,100 to 1,200 francs, and produced a pretty mean effect. Here, then, is an application of considerable importance, where the electric light shows its superiority in an indisputable manner, from every standpoint. Let us remark, however, that this considerable difference in price will not occur where the electric lighting takes place on a small scale. In such cases, gas will undoubtedly assert its advantages. Very soon, on the occasion of the opening of the "salon," we shall finish this article by giving some information as to the lighting of the Palais de l'Industrie, at which the electric light is to figure to a still greater extent than it did last year. Whatever be the results obtained on this occasion, the fact is none the less established that the electric light has definitely earned a place for itself at night. But that its success be not compromised, it will be well to act with prudence and to extend the field of its applications only in proportion as improvements are made in it. Gas and electricity will then, without placing themselves in the position of competitors or rivals, be able, on the contrary, to lend each other mutual aid by the choice of a field of applications which, leaving their inconveniences in the shade, will put their respective advantages in the best light.

COMPOSITION OF LEAVES OF DISEASED VINES.—By E. ROTONDI and A. GALIMBERTI (*Bied. Centr.*, 1879).—Diseased vine leaves contain more moisture than healthy leaves, and in the dry matter there is a higher percentage of nitrogen, ash, phosphoric acid, potash, and soda.

than one man can furnish, it is desirable to increase the number of glass plates and turn at a higher speed. Charging and discharging a large Leyden jar forty times a second, the discharge spark being one centimeter long, the noise was insufferable, the single sparks were indistinguishable, and a light of one to four candle power was obtained. Three such induction machines being coupled together, and the battery of Leyden jars being discharged eight to ten times a second through a platinum wire 0.3 mm. in diameter, the wire remained permanently hot. The current could decompose water, but it required thirty-eight minutes to produce one cubic centimeter of explosive gas. The insulating cement employed in the construction of the induction machine deteriorates from use so that it has to be regularly renewed.

INFLUENCE OF ATMOSPHERIC ELECTRICITY ON LONG UNDERGROUND TELEGRAPH CONDUCTORS.

MARMANN.—There is no doubt about the fact that atmospheric electricity affects subterranean lines, and this occurs through the discharge of thunderclouds or similar causes producing currents in the earth over the wires, and also because the underground wires, having the same earth connections at the end as certain overhead wires coming to the same offices, are affected by the disturbances in these wires. The German telegraph administration made, last summer, a series of inquiries as to how far these disturbances affect the work of the great underground conductors of the empire, and they have found that in the underground system the disturbance is very much less than in the overhead system. Again, they found that on the underground system disturbances showed themselves to be stronger in the Hughes system than in the Morse. In the Hughes, false signals occurred, single letters and even whole words being omitted, whereas in the Morse only a few signals were slipped. The

* The lights being equal, the voltaic arc gives out two hundred times less heat than a gas jet burning 100 liters per Carcel burner.

disturbances were especially great when thunderstorms burst over the places where the lines went to earth; but, indeed, the disturbance was always great immediately underneath discharging thunderclouds, even when there was no earth connection, and they seemed to be as great, whether the thunderstorm crossed the line or went along the line. Lastly, when disturbances occurred near one end of the wire going to earth, very little effect was seen at the other. During a very severe thunderstorm which showed itself at one end of the line, and produced frequent and strong discharges, the whole apparatus attached to the overground system was so much affected that messages could not be sent; but although the thunderstorm was moving in the direction of the underground wires, so little disturbance was observed on them that the work went on in the usual way. Suddenly, however, a Morse instrument attached to one of the underground wires stopped working, and was found to be damaged, and a horse in a building about five meters from the underground wire was also hurt by the shock. But it was found that this underground wire was connected with earth by the same copper wire which served for several overhead lines, and on one of these overhead wires a galvanoscope was simultaneously injured. The injury on the instrument attached to the underground wire really arose from the same wire being used as an earth lead for both the underground and the overhead systems.

IS THERE DANGER IN CARRYING A LIGHTNING CONDUCTOR INTO A POWDER MAGAZINE?

HERMANN AXON.—If any conductor be exposed to the action of the clouds one or other of two things has to be feared, either a direct discharge from the clouds into the conductor or a "back stroke"—that is, a discharge from the conductor into the earth on the sudden neutralization of the electrified cloud which has induced the charge in the conductor. If a body be inclosed in a case formed of a perfectly conducting substance, it is, as is well known, screened from both these actions; but if the screen has only limited conductivity, like the earth's crust, effects in an underground wire may be induced by atmospheric causes. To test this an ordinary electric machine was employed, and, as a detector of current, either a frog's leg or a telephone. One end of a coil of insulated copper wire, 122 meters long, was successively attached to either the frog's leg or to one end of the telephone, another wire passing from the frog's leg or from the other end of the telephone to earth. In a distant room, in which the greater part of the wire was coiled up, the other end was insulated, and sparks were drawn from a neighboring electrical machine by a conductor attached to the earth. Each time a spark passed, the induced effect was visible on the distant frog's leg or telephone, showing that the apparatus was sensitive for detecting back stroke in overhead wires. The experiment was then varied by placing the coil in a tub of salt water, under the water but near the surface, and connecting the water with the earth. It was then found that no effect could be observed either in the distant frog's leg or in the telephone on causing sparks to pass the machine into the water, provided that the water made a good earth. When, however, twenty Siemens units were inserted between the water and the earth, faint sounds were heard on the telephone, and on inserting eighty Siemens units visible motion was observed in the frog's leg. Experiments were then made to prove that the portion of the covered wire immersed in the water was well insulated, so that the effect observed could not be due to leakage of electricity from the water into the wire, but was really an inductive action in the wire from which the surrounding water did not shield it. Dr. Siemens mentioned to the author of the paper that in the same way sparks were to be feared near the ends of underground wires well insulated from the earth and buried in dry ground.

UNDERGROUND TELEGRAPH WIRES.

The underground telegraph lines established by the German postal and telegraph administration in 1876-79 have a length of 2,274 miles, consisting of 17,380 miles of wire. The article gives the principal towns connected in this way, with the distances between them, and states the names of other numerous lines which are to be finished in 1880. The test thus given to the system has led to such satisfactory results that it is being introduced into other states, the most important being France, where a credit of eight million francs has been given for this purpose for a length of 600 miles.—*Electrotechnische Zeitschrift*.—*Jour. Soc. Tel. Engineers*.

IMPROVED TELEPHONE CALL.

THE Boston *Advertiser* describes an improved telephone call signal, which is about to be introduced in that city. It is not of application where a subscriber has a private wire, but is for use in the smaller cities where several subscribers are on the same wire, and, when one is called, all hear the bell, and each must have his separate call. It is a device by which only the person desired may be called, and so, without any particular style of call, as at present, he knows whenever he hears the bell that it is for him. The apparatus is something like this: At the central office is a clock which regulates a clock in the office of each subscriber on the circuit, so that they may all run in exactly the same time. This is done by setting the subscribers' clocks, so that whatever variation they have will make them faster than the central clock, and by a current of electricity they are made correct once in every minute. Upon the faces of these clocks and the central one is a dial around the second hand, marked off into as many divisions as there are subscribers on the wire. Whenever the second hand is in the division marked "1," the subscriber who has that number may be called and no other one will hear the bell. The same is true of No. 2, and so on around the circle. Suppose there are eight subscribers on the wire, each would have seven and a half seconds every minute in which he could be called—deducting a brief interval of silence at the beginning, which is given in order that the calls may not be mixed. As two seconds is ample time for calling a person, it will be seen that there is a good margin allowed. The apparatus is simple. A wire extends from each clock to the central clock, and at each clock is an electric call bell. A single cell in the battery is used, which gives enough electricity to call one bell, but not two. The possibility of the invention turns upon the fact that electricity will take the shortest path possible. When the bells are silent the electric current is passing along a direct line of wire, but when the bells sound the current is passing through several hundred feet of wire coiled at the bell which closes the circuit when the fingers press the key in the central office. This change in the circuit is made by a simple arrangement in the clock, by which a lever is thrown in one position or another, turning the current into the coil or sending it straight on. If there were enough electricity

on, the bells would all ring, but only enough is generated to ring one bell, and that bell is the one which, for the time being, is affected by the electricity in its coil. Since only one coil is affected at one time, only one bell will ring, and when a subscriber hears it he is sure it is for him. Mr. George H. Bliss is the patentee, and the patent is owned by the Signal Telephone Corporation.

TRANSMISSION OF MOTION BY ELECTRICITY.

M. DEPREZ has recently succeeded in transmitting, by means of an electric current, the motion of a motor to an axis placed at some distance from the same, in the same manner as a rigid axis between the two would do, so that the angular velocity is always equal in amount. On the shaft of the transmitter are fixed two commutators, each of which reverses the current that traverses it twice during each revolution; the positions of the shaft corresponding to each inversion do not coincide, however, but follow each other at intervals of a quarter of a turn. The receiving apparatus consists of a permanent magnet or electro magnet, between the branches of which are two straight electro-magnets, capable of rotating round an axis which coincides with that of the magnet. The currents sent through these electro-magnets from the commutator on the motion-shaft determine the revolutions of the second shaft, with conservation of the angular velocity, which has not been realized in any electric motor hitherto devised. The speed capable of being thus transmitted may vary from 1 to 2,400 revolutions per minute. The alternating currents required may be generated by a magnet or dynamo-electric machine. M. Deprez's system is capable of transmitting any kind of motion, and by suitable mechanism might be applied to the reproduction of writing, drawing, etc.

PHYSICS WITHOUT APPARATUS.

IDEAS relative to weight of bodies, to center of gravity, and to stable and unstable equilibrium, may be easily taught and demonstrated by means of a large number of exceedingly familiar objects. When a box of soldiers, carved out of elder pith, and fixed to a hemispherical piece of lead, are put into the hands of a child, he possesses all the requisites to perform some very easy experiments on the subject of center of gravity. According to some persons, it is not impossible, with a little patience and a steady hand, to cause an egg to stand, evenly balanced, on one of its ends. To be successful with this experiment it should be performed on a very horizontal surface—on a marble mantel, for instance. If the egg be then caused to stand upright it is, as the most

paratus losing its equilibrium. The vertical of the center of gravity here again passes through the point of contact. Although the forks oscillate with the cork which supports them, the whole thing is much more stable than we would



FIG. 3.—EXPERIMENT ON CENTER OF GRAVITY.

be led to suppose. This curious experiment is often performed by prestidigitators, who announce to the spectators before whom they are exhibiting that they will undertake to empty a bottle while the cork remains on the neck. The



FIG. 1.—EXPERIMENT ON CENTER OF GRAVITY.

elementary principles of physics indicate, because the vertical of the center of gravity passes through the point of contact of the end of the egg with the surface on which it rests. Fig. 1 shows a curious experiment in regard to equilibrium, and which is performed much more easily than the last-

experiment is performed on the principle just indicated. In 1874, a correspondent of the *Magasin Pittoresque* published in that journal the foregoing experiment under a more complicated form. Says he: If a woodcock or any other long-beaked

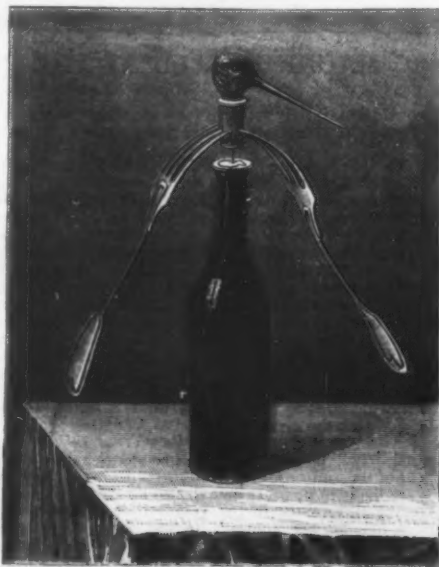


FIG. 2.—EXPERIMENT ON THE CENTER OF GRAVITY.

mentioned. Two forks are stuck into the opposite sides of a bottle cork, and the latter is placed on the neck of a bottle. The forks and the cork form an object whose center of gravity is located above the point of contact with the bottle, and the latter may therefore be tipped over (and even emptied if it be full of liquid) without the experimental ap-

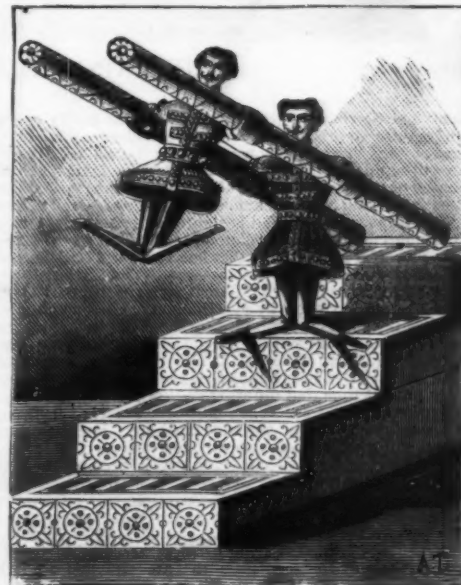


FIG. 4.—AUTOMATIC FIGURES.

bird be served at a repast, separate the head from it along with a portion of the neck. Then insert the neck pretty firmly in an aperture in the cork, and in the latter stick two forks, just as in the preceding experiment. Afterward a pin is to be inserted into the lower extremity of the cork to

serve as a pivot. This little apparatus is now placed on a coin lying across the mouth of the bottle, and, when its equilibrium is made sure of it is made to spin around quite rapidly (Fig. 2). Nothing is more amusing than to see the long beak of the bird turning successively toward each of the guests seated around the table, and sometimes too with little oscillating motions that give the head the appearance of being endowed with life. The apparatus will continue to rotate for some little time, and meanwhile bets are often made by the guests as to before whom the beak will stop.

The same journal gives another experiment of the same nature, but which is more difficult to understand because we do not see at first where the vertical of the center of gravity is. The question is to cause a silver coin to rest at equilibrium on its circumference against the external edge of a goblet (Fig. 3). To perform this experiment the coin is inserted between the tines of a couple of forks; and, while the

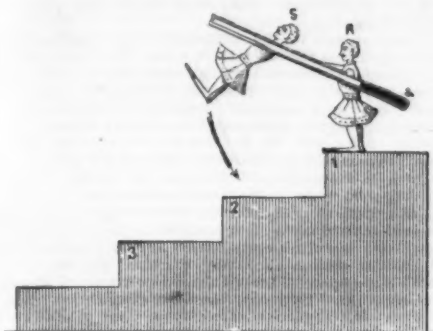


FIG. 5.—SECTION OF THE TOY.

edge of the coin rests on the edge of the goblet, the position of the forks is shifted by degrees until they nearly reach the edge of the coin. The whole will then be in equilibrium. The center of gravity of the figure formed by the forks and coin is found at the center of the circumference formed by the edge of the goblet. In physical cabinets there are often found cylinders of wood which roll up inclined planes without any impulse being given them. At first sight this fact is surprising, but it ceases to be astonishing when we learn that the center of gravity is situated very near one of the surfaces of the cylinder on account of a mass of lead which has been placed there. Fig. 4 is a very faithful representation of a plaything which is sold on the boulevards of Paris during the first months of the year. This little apparatus, which has been known for a long time, is one of the most pleasing applications of the principles relating to the subject of center of gravity. Any one with the least ability can make the toy for himself. It consists of two figures which revolve about axes fixed to two parallel tubes containing

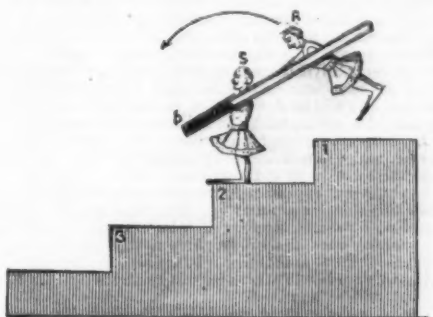


FIG. 6.—SECOND POSITION OF THE FIGURES.

mercury. When the toy is placed in the position shown in Fig. 5, the two figures remain immovable; but if the figure S is depressed so as to make it stand on the second step, as shown in Fig. 6, the mercury flows down to the other end of the tube, the center of gravity is suddenly changed, and the figure R makes a complete somersault in the direction shown by the arrow. It then rests on the third step, and the same effect takes place with the figure S, and so on, as many times as there are steps to descend. The laws of equilibrium and of the displacement of the center of gravity are studiously observed by jugglers, who perform wonderful feats, but which are generally facilitated, however, by the rotatory movement given to the objects with which they perform. The juggler who balances on his forehead or chin a slender rod at the extremity of which a plate is revolving would never succeed in repeating this experiment did not the plate revolve about its axis with very great rapidity. It is because the speed of a body compensates for its small mass. It is hardly necessary to observe that the motion of the top tends, in the same way, to keep it upright.

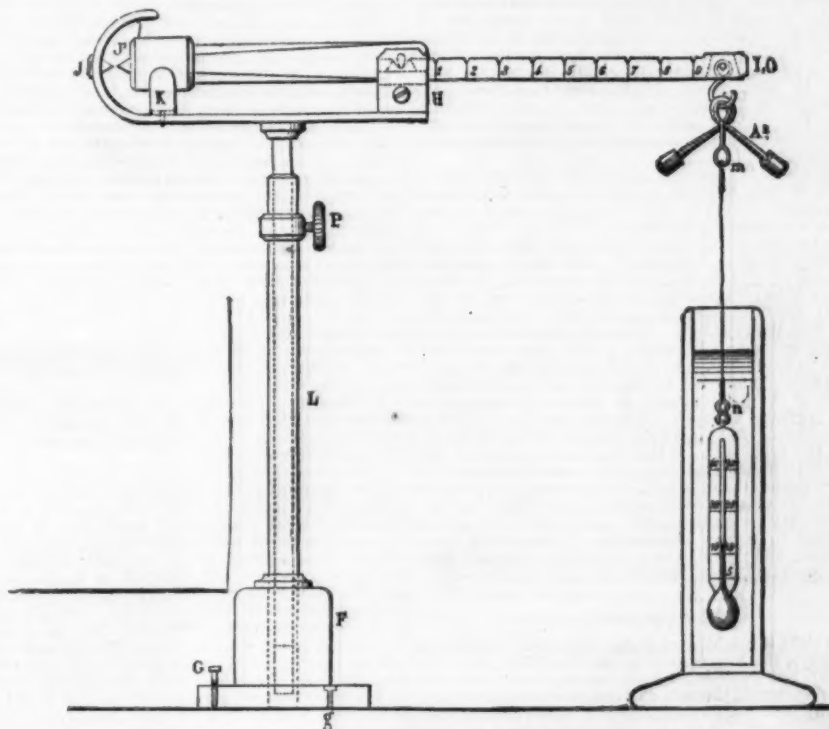
AREOTHERMIC BALANCE FOR DETERMINING THE DENSITY OF LIQUIDS.

This new apparatus, invented by M. Blondeau, possesses numerous advantages over the areometers usually employed in the arts and industries, the principal of these being the facility with which the operations may be performed and the readings taken, the approximation of the specific weight up to the fourth decimal, and especially because the instrument may be used for every kind of liquid, be it either heavier or lighter than water. The general arrangement of the balance ready for operation is shown in the accompanying engraving.

F is the supporting base; G, a screw for leveling the balance; g, g, screws, which, with the screw, G, serve to fix the base of the apparatus. L is a hollow column in which the upper part, K H, of the support, moves up and down. P is a binding-screw to hold the beam of the balance at any height desired; H, a bearing on which rest the knife blades that support the edges of the beam; K, the scale-beam guide; J J', points serving to show the equilibrium of the beam; A¹, a weight which is suspended from the hook of the tenth division when the specific weight of the liquids heavier than water is sought; m, n, double S-shaped hitches

for suspending the plunger (a sort of float containing a thermometer) from the hook of the balance so that it may dip into the liquid whose density is sought, and which contains the test-glass. One of the arms of the beam carries at its extremity a cylindrical counterpoise in the center of which is the point, J'; and the other is divided into ten equal parts numbered from 1 to 10. At each division there is an angular notch for receiving a weight, which will be spoken of further on. Before proceeding to ascertain the specific weight of a liquid care is to be taken to see that the balance, as it rests upon the table, is perfectly level. This is done by suspending the plunger (without putting on the weight, A¹) to the hook of the beam. If the balance is level there will be an equilibrium, shown by the points, J J', being in concordance. If not level, it is made so by turning the screw, G, to the right or left, as the case may be, till there is a perfect equilibrium. The apparatus being level, if distilled water at a temperature of +15° C. be put into the test-glass, and the thermometer float be plunged therein, the equilibrium will be broken; but, by hooking on the weight, A¹, the equilibrium will be re-established, the two points, J J', will again be in concordance, and the apparatus will indicate 1 as the value of the density. (See figure.) The weights which are used to determine the density are of a horse-shoe shape, with a sharp inside edge at their upper part so as to fit into the notches in the beam. These weights are hooked at their extremities so that they may be suspended from one another when the same decimal is repeated in the number which expresses the density. Designating the different weights as A', A, B, C, and D, it must be remembered that:

(1) The weights, A', A, and A, are equal; (2) The weight B is equal to 1-10 of A; (3) C weighs 1-10 of B, or 1-100 of A; (4) D weighs 1-10 of C, or 1-1,000 of A.



NEW AREOTHERMIC BALANCE.

To Find the Density of a Liquid Heavier than Water.—The balance being level, the liquid whose density is sought being in the test-glass, and the weight, A¹, having been suspended from the hook (as shown in the figure), we first try to establish an equilibrium by successively putting the different weights in the notches of the beam, or by suspending them from each other, as the case may be. Supposing, for example, the specific weight be represented by number 1.668, the weight, A¹, denotes the unit of the whole number, the weight, A, will have been placed in the notch 6, the weight, B, hooked on to A, and the weight, C, placed in the notch 8. Since A represents tenths, B hundredths, and C thousandths, we shall, therefore, read this figure, 1.668.

To Ascertain the Density of a Liquid Lighter than Water.—The operation is performed exactly as the first case; only the weight, A¹, must be taken off, and the weights, A, B, C, D, must be employed.

It is very easy to verify, with the apparatus itself, the correctness of the divisions of the beam by means of the weights, and that of the weights by means of the beam. This peculiar property of the instrument is of very great importance, and is not found in any other apparatus for determining the density of liquids.

A NEW PHOTOMETER.

It is well known that in order to employ the different photometers now in use (except, however, Arago's and a few similar apparatuses), the sources of light must be so arranged that the rays from one, received on a screen, must be apparently equal to those of the other, which are received on the same screen. The relative distance of the two sources from the screen gives the ratio of intensity—the feeblest source being taken as unity. When it is a question of feeble luminous sources a spermaceti candle is usually taken as the type; but to estimate the value of lights of greater intensity, the Carcel lamp is used. There are various reasons, not necessary to enumerate here, why these apparatuses are defective and cumbersome, but which are all obviated in a great measure by a new photometer, invented by M. D. Napoll. This apparatus, figured herewith, occupies little space, is convenient of manipulation, and is very simple in its operation. It differs particularly from other photometers in the fact that the two luminous sources are equally distant from the apparatus, and in fact may be situated at any distance whatever. The principles on which the valuation of the intensity of light are based are the following:

(a) If, through a hole in the wall of a darkened room, there be allowed to fall on the opposite wall the light emitted by any luminous source whatever, the illuminated spot appears equally intense throughout its whole extent, on

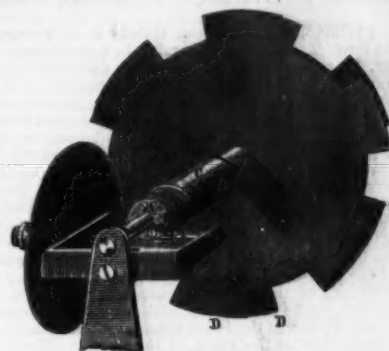


FIG. 1.

condition, be it understood, that the rays be as parallel as possible. By reducing the hole one-half the quantity received on the wall of the room will be also one-half, and so for any diminution whatever of the aperture; and the light

received on the wall will be directly proportionate in quantity to the corresponding diminution of the hole.

(b) If, now, for the non-illuminated wall of the darkened room there be substituted an opaque disk containing an aperture at any distance whatever from the center, and if

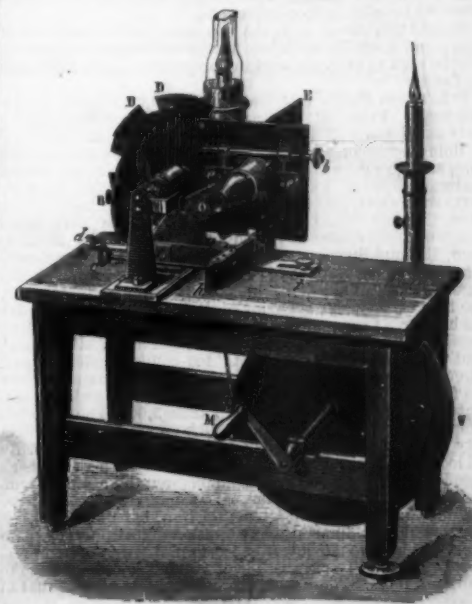


FIG. 2.

the source of light be placed opposite this hole, we shall see, on revolving the disk, the image displaced circularly on the screen and forming a uniformly luminous ring, in consequence of the persistence of the impression on the retina. The luminous intensity of this ring is independent of the

velocity given the disk; and this fact is abundantly proved by various physiological considerations as well as by experience. The intensity depends on the area of the hole; and if, while the disk is revolving, this aperture be increased or diminished, the ring will be more or less illuminated, and proportionally too to the size of the aperture, as above explained.

These principles having been stated, it only remains to explain how M. Napoli's apparatus is constructed. At D (Fig. 1) are two disks of the same diameter, placed in juxtaposition, and having six wide openings on their circumference. These two disks move one on the other in such a way as to present spaces of greater or less breadth at the will of the operator. One (D) is mounted on an axle which is rotated by a winch, M (Fig. 2), a fly-wheel, V, and an endless cord. The other disk (D') is movable on the axis of the disk, D, and is provided with a helicoidal groove in which fits a pivot fixed to the sleeve, C (Fig. 1). The latter, by means of a keying, is made to move longitudinally in a second groove cut into the axis of the disk, D, and terminates in a circular rack which is actuated by the button, B, and the pinion, P. By turning the pinion one way or the other the rack of the sleeve advances or recedes, and the pivot which works in the helicoidal groove of the cylinder of the disk, D, forces the latter to move on the disk, D', a distance depending on the pitch of the screw. The pitch of the screw is so calculated that the total run of the sleeve, backward and forward, causes one of the disks to completely cover the other, thus intercepting all light or opening wide all the apertures. At the end of the pinion, P, at B, there is an index which marks on a dial divided into 180 degrees, the exact degree of opening of the apertures. At O (Fig. 2) is an eye-piece placed in the end of a cone-shaped telescope, which is closed at the other extremity by a piece of unpolished glass. In the vertical axis of this telescope, beyond the unpolished glass, there is an opaque screen E, designed for separating the rays emitted by the type-light from those which proceed from the light to be studied. This screen, by means of the button, c, and the rack, A, may be made to advance or recede, and thus form two tangent images on the unpolished glass. Another button b allows the two plates, c, and c', to be approximated to any degree, thus increasing or diminishing the luminous field at the operator's will.

To make use of the instrument the two lights are placed at an equal distance from the unpolished glass, and at such an angle that the screen, E, may form a bisector of the latter. With the right hand the winch, M, is revolved at about one turn per second, thus impressing on the disks, D D', a velocity of thirty revolutions. The eye is placed at the eye-piece, O, and, by means of the button, B, the apertures of the disks are opened or closed, so as to obtain on the unpolished glass luminous images of the same intensity. The rays from the type-light, which is placed to the right, fall directly on the unpolished glass; while those emitted by the source to be studied, and which pass through the apertures on the circumference of the disk, arrive at the left. The needle of the dial indicates the number of degrees to which all apertures are open. The ratio of this number to the circumference (360°) gives the value of the units as the power of the type-light. If this quotient is 3, 4, or 5, for example, that means that the source studied is 3, 4, or 5 times more intense than the light taken as unity. It may be objected that this estimate will sometimes be subject to error. Such a case may certainly present itself; but it will always be allowable to correct observations by repeating them several times; and this may be very easily and rapidly done with this apparatus, since there are no lights to be moved.

ICE AND IRON.

At first sight it might appear that iron and water act in opposite ways, the former contracting to solidity, the latter expanding; but Professor Tyndal has shown ice to be capable of being forced through dies and into moulds without permanently breaking its continuity. If, from these properties, we look upon ice as a plastic material, then the two substances are not dissimilar in their action, as the water, like iron, expands in cooling from the liquid to the plastic condition, and then continues to contract.

I am not aware that this remarkable phenomenon of the freezing of water is ever referred to chemical action, and unless some chemical theory should satisfactorily account for this reversal of the ordinary law of contraction in the case of iron, we shall have to look upon it, as in the case of water, to be the result of changes in the ultimate particles of matter which a greater knowledge of molecular physics alone will enable us to comprehend.

Should this theory as to the expansion and contraction of iron stand scientific criticism, further interesting analogies will be seen to exist between the properties of this substance and water.

It has been shown that water in cooling contracts until it reaches 39° Fahr. It then expands 9.3 per cent. through a very small range of temperature (between 39° and 32°) and in doing so becomes ice at 32°. A further lowering of the temperature causes contraction, and the ice becomes harder and more brittle. Ice, very near its melting point, becomes soft, and exhibits all the properties of a plastic body. The view that ice passes through a plastic state of very small range of temperature has been held by Forbes, Clerk Maxwell, Balfour Stewart, and other eminent men of science. The opinion has not been held without controversy; but assuming that this plasticity in ice is an intermediate state, see how exactly the behavior of iron and water resemble each other. Commencing at the liquid end, each in cooling expands into the plastic state, then a reversal takes place, and the plastic body contracts. Ice cannot under natural circumstances be lowered very much in temperature below its freezing point, as it is already so low in the scale of heat; but iron can come down more than 2,000° Fahr., and in doing so contracts its volume to such an extent that its density becomes greater than its own fluid. To get the density of ice equal to the density of water, would (taking Brunner's coefficient of dilatation as continuous) require a fall of temperature equal to 1,400° Fahr. The diagram of water passing into ice would resemble that of iron, but the line of volume would terminate near its position of maximum expansion. If it were possible for ice to fall 1,400° of temperature, after solidifying, the line of volume would continue to fall, and the diagram would probably be similar to that of iron.

Now there is a very extraordinary property of ice which was first noticed by Faraday. If two pieces of wet ice—that is, ice at 32° Fahr.—be pressed with their wet faces together, they at once freeze, and become perfectly united.

The difficulty in accounting for the freezing of the intercepted water is this: The ice is at 32°, the water at certainly not a lower temperature. If the water gives up its heat to

the ice, its heat must melt it. From whence, then, arises the abstraction of heat which causes the intercepted water to freeze? The difficulty of explanation is increased when it is found that this regelation will actually take place under hot water. Several explanations have been given, but I will only give you that adopted by Sir William Thomson and Professor James Thomson, and defended by the great German philosopher Helmholtz.

If heat be applied to most substances, the effect is to cause expansion—that is to say, heat is converted into work by moving the particles farther apart. Conversely, if you take any such substance and compress it, the body becomes heated, that is, you change the mechanical work of compression into heat.

But there are some substances which, instead of expanding by heat, contract. India-rubber is one which is, under certain circumstances, affected in this way. If you heat a band of India-rubber with a weight attached, you will find the weight is slightly raised. Water, as I have explained, is (within the range of 32° to 39°) another example.

How, then, should these substances act when compressed? Professor James Thomson, of Glasgow, first worked this question out theoretically, and came to the conclusion that substances which contracted when heat was applied, should, when compressed by mechanical power, become colder. Experiments subsequently made upon the compression of ice by Sir William Thomson and others entirely confirmed his calculations. With regard to India-rubber, a compression will be found to cool it, and, conversely, a drawing out of the India-rubber warms it. If any one will take a band of this substance and put it to his lips to judge the temperature, then suddenly stretch it out, on application to the lips again the band will be perceptibly warmer. This is in opposition to our experience of other bodies, which generally become colder by expansion.

Now the view taken by Sir William Thomson and Helmholtz as to regelation is this: When the faces of ice, with water between them, are pressed together, the soft and watery ice being a substance which contracts with heat, cools by pressure, and this disappearance of heat lowers the temperature of the water between the two faces of ice and produces the interesting phenomenon of regelation.

Let us carry this analogy between water and iron a step further. From the time of Tubal Cain downwards, the capability of welding possessed by iron, has made it the most indispensable and intrinsically valuable of all our metals. The process of welding is looked upon generally as an adhering together of the surfaces of a substance which have been heated to plasticity. But how is it we do not find this property of adherence in all other metals even though heated to the same extent? The answer according to the theory now proposed is to be found in the anomalous conduct of iron in reversing the progress of its change of volume between certain limits of temperature.

Iron, when at welding heat, has its surface in a semi-liquid state. In this condition you place it in contact with another piece of the same heat.

The molecular conditions of the plastic iron which has already expanded, and of the semi-fluid iron at the surface which is just commencing to expand, are quite different, as also are their temperatures.

If this iron were similar to other bodies, and a blow or sudden pressure produced heat all through the mass, the unexpanded semi-liquid at the surface as well as the interior plastic iron already expanded, would rise in temperature; the consequence of which would be, that the molecular conditions at the junction would still differ, although both at a higher temperature; and therefore, molecular union could not take place. But if the iron at the surface of the weld is in that condition of temperature that it would cool by pressure, the result is quite different, as the blow or pressure acts on the plastic iron to increase temperature, and on the surface iron, which is on the border land between liquidity and plasticity, to produce cold; consequently there is a moment when the temperatures of the two would meet each other, and render the molecular condition of the junction uniform and continuous throughout.—Thomas Wrightson.

SOME RECENT ADVANCES IN PHOTOGRAPHY.*

By CAPTAIN ARNEY, R.E., F.R.S.

THE GELATINO-BROMIDE PROCESS.

SOME few years ago, Mr. J. Spiller, F.C.S., had the honor of reading a paper on this same subject before this section of the Society of Arts, and, when he did so, he had one advantage which I have not, in that the advances made up to that time, and which it would be unnecessary for me to recapitulate, admitted of lecture experiment much better than do the more modern advances; and it must be remembered that the ability to experiment depends largely on the nature of the processes described. My work will commence where Mr. Spiller's left off. At that time, viz., 1855, negative processes were very far behind what they are at the present day, and what may be called "a new departure" has been made during the last two years. This new departure is the gelatino-bromide process. Now, as this paper to-night will be recorded in the Society's *Journal*, I must be excused, though it may be familiar to many, if I give an outline of this process, and if I recapitulate its advantages and disadvantages over the old wet collodion process. Roughly speaking, a gelatino-bromide emulsion consists of a finely suspended sensitive salt of silver in gelatine, and the method of producing such suspension may be affected in one or two ways. The only way that I shall attempt to describe is that most ordinarily practiced, which is that a certain amount of soluble bromide (if silver bromide is required in the emulsion) is dissolved in a weak solution of gelatine; silver nitrate in solution added gradually, and with stirring, till finely suspended silver bromide is produced. I do not wish to enter into any controversy as to whether Dr. Maddox or Mr. Burgess should have the credit of first bringing into notice this process, and I had rather not decide; but I may say that Mr. Kennett was the first who gave what may be called a really workable process to the photographic public, publishing such details as enabled others besides himself to prepare an emulsion. After making advances, one is apt to forget by whom the foundation on which they have been made is laid, and I am sure that, in the gelatino-bromide process, this is very much the case, myself being included amongst the number of forgetful ones. There are certain physical qualities in silver bromide which conduce to sensitiveness, the principal one being, perhaps, a certain coarseness of grain, such coarseness being only effective when the grains are gradually built up, as it were, of finer grains. To effect this, Mr. Kennett first proposed to keep the gelatine, with the suspended salts, in a liquid condition, at about 90° Fahr.,

for from three to seven days. The longer the cooking, the greater the sensitiveness that was obtained, though, after a certain point, the vigor of the developed image was certainly wanting. A later plan—instead of emulsifying for such a long period, and running the risk of the gelatine decomposing—is to boil the emulsion, to which only a small quantity of gelatine has been originally added, for half an hour, and afterwards to add gelatine till it attains a proper setting consistency. The physical characteristics of the sensitive salts are similar in each case. The sensitiveness to light of a plate coated with either of these emulsions, and allowed to dry, is something marvelous; and here we come to the first advance made in the process—an advance of no small moment, considering that we now can photograph in one second of time what previously it took at least thirty seconds to secure. I need not detain you with a description of the washing out of the soluble salts from such an emulsion; it is sufficient to say that their elimination should be very complete, the sensitiveness being very largely dependent on its thoroughness.

We now come to the advantages and disadvantages of this process over the old wet process. The sensitiveness of these plates is, perhaps, their greatest charm; and, when it is said, and truly, that a plate can be prepared which needs but 1-800th part of a second's exposure to secure a soft and harmonious negative when a view is fairly lighted, there is a feeling that a new era has dawned in photographic art. Instantaneous views are now possible under circumstances which were impossible; for instance, we have here a picture of foliage and water by Mr. Gale, in which he has absolutely caught a swallow poising in the air over the pond, the shadow and reflection of it being perfect. Such a combination of adjuncts would formerly have been impossible, but here we have it almost absolutely perfect. Mr. England has kindly sent me some beautiful transparencies of instantaneous negatives, which also show its capabilities. Another advantage in the process which I have thus briefly sketched is the excessive cleanness of the plates; no mottled skies or stains disfigure a picture; and not only is there cleanness in the plate, but there is cleanness in the development, though this attribute is shared by other processes. One more advantage, too, has the gelatino-bromide, and that is the wonderful power it has of keeping the impressed but invisible image from fading away after the plate is exposed, and before it is developed. In my own experience, a plate which has been exposed six weeks ago can be developed to-day as perfectly as it could be immediately after the image was impressed. Others, too, I believe, have tested this quality in the plates, and their experience coincides with mine. If a plate will keep six weeks, it will keep six months, and, I might say, six years, since the most crucial time in other processes for the fading to commence is about a fortnight after exposure. Before exposure the plates will keep, I believe, indefinitely so long as they are not kept in a very damp atmosphere, and if they have no glycerine mixed with the gelatine. Here, then, we have positive advantages in a dry plate process, which before could only be considered as problematical. We now come to the disadvantages of the process; and the first is the most serious to my mind, and that is the fact that the development and the giving of density to the image is almost completely out of the hands of the photographer—he must let come what will. I do not mean to say that a general intensity cannot be given, for it can; but what I mean to affirm is that local intensity is very difficult to give. I will show you what I mean. Here I have two negatives; one thin, and the other intensified by means of the deposition of silver from a pyrogallate of silver solution. It will be noticed that in the latter locality intensity has been given, while in the other it is completely absent. Now these negatives were taken by the collodion process, and intensification by means of silver was safely conducted with very ordinary care. With a gelatine plate, unless extreme care be used, such a mode of intensification is inadmissible. For an artist, then, who has his own ideas regarding light and shade, and who uses the intensifier as the painter does his brush, there is a certain drawback in the use of gelatino-bromide plates; but to the artist who works in a studio, in which he can twist his light as he will, there should be none.

The modes of general (not local) intensification at present in vogue with those plates is dependent on the action of a mercury salt. This is a treacherous substance to deal with—when collodion is employed, at all events. I have a bad example here to show you, where the negative is turned of a lemon yellow color. Whether it will act so with gelatine is a question which time alone can settle.

The next disadvantage, till quite lately, was the fact that the light which had to be employed in the developing room was of a red hue, coming through various thicknesses of ruby glass. This, as all workers are aware, is a very painful light for the eyes, and, where the quantity is reduced, it becomes a very serious matter to the photographer, whose sight would probably be injured by much work in it. This is overcome by a suggestion I made—and carried out—that a small proportion (say one-eighth) of silver iodide should be used with silver bromide, which, up till now, has been the universal silver salt employed. More than a year ago, I carried out my first experiments with the photo-spectroscope in this direction, and found that, as you increased the quantity of silver iodide in the emulsion, so you diminished the sensitiveness of the plate to the red, orange, yellow, and green rays, till by using one-fifth iodide, the spectrum would only impress itself as if on a wet plate. This slide will show what I mean. The lowest photograph of the spectrum is taken on a plate in which there is no iodide, the second contains one-twelfth, and the third one-eighth part of iodide to one of bromide of silver. This means, then, that with one-eighth iodide of silver to one of bromide, orange light can be used with impunity when coating and developing plates with such an emulsion. During my recent experiments I found Mr. England working with iodide, and he, as well as myself, remarked on the wonderful clearness of the shadows that the addition of iodide gave; which is a second benefit it conferred, since it caused not the least loss of sensitiveness to the upper part of the spectrum, which many at first were (and may still be for anything I know to the contrary) disinclined to believe. I think, then, that in the gelatino-bromide process, we may say the addition of the iodide is a benefit. Were I to enlarge on this fascinating theme, I should, I am afraid, take up the whole hour which is allotted to me; but, as I have several more subjects to introduce to your notice, I must hasten on.

With the gelatine process, I have commenced, perhaps, where I ought to have ended, and I must hark back. In Mr. Spiller's paper is mentioned briefly the collodio-bromide process in which silver bromide is held suspended in collodion and used on a plate in a similar manner to the gelatine. There is a great advantage in this process, in that the emulsion occurs readily, the solvents being very volatile; but it

*A recent lecture before the Society of Arts, London.

is not so rapid, at present, as the gelatine process, for a reason which I shall endeavor to explain.

PHOTO PLATES WITHOUT GLASS.

Before doing so, I must call the attention of the meeting to an adaptation of collodion emulsion and a flexible support. This does away with the necessity of glass, and its consequent weight, and, it also enables rolls of sensitive material to be stored in the camera itself, and, by merely turning a screw, to place inside fresh portions of the band ready for exposure. This discovery, in its present practical form, is due to Mr. Warnerke, whose name I shall have to mention several times before I close my paper. I will very briefly explain how this tissue is manufactured. Plain paper is first given a layer of India-rubber solution, then one of plain collodion, next, another of India-rubber, and so on till five or six such coatings are given, the final one being of India-rubber. Collodion emulsion is then poured over it and allowed to dry, and the tissue is then ready for exposure. After development the back of the paper is moistened with a little turpentine, and the film bearing the image strips off. I have here several examples of these filmy negatives, and would remark that to print them it is merely necessary to place them on glass. When Mr. Warnerke shall have introduced a flexible support for gelatine emulsion, we shall have nearly the *no plus ultra* of photography as far as negatives are concerned.

I would now point out that it is perfectly feasible to bring the silver salt into the same physical condition as in the gelatine bromide in collodion emulsion process, but then the dried media which holds it on the plate are physically very different. Gelatine is a colloidal body, separating one particle of bromide from another by a wall of matter pierced with difficulty by the water of the developing solution. The collodion, on the other hand, is a network in which is imprisoned the salts, which are, in consequence, readily accessible to the active reducing power of the developer. The question arises—What effect has this? The answer is simple. The alkaline developer will reduce silver bromide, which has not been acted upon by light, in an almost equal degree as it will that which has been acted upon by light, if it have free access to it, and if a powerful retarding agent, such as a soluble bromide, be not added to it. This retarding agent checks the development, and has a tendency to destroy the previous action of light. Owing to the nature of the gelatine, it acts as a restrainer and not a retarder; and here a smaller quantity of bromide need be used, with the result that, although in both cases the physical nature of the silver salt may be such as to give the extreme sensitiveness, yet, in the one case, the effect produced by light is greatly destroyed, and in the other very little; hence, probably, the great cause of difference in rapidity of the two processes. With collodion, however, we can get a physical condition of the bromide which is different from any which can be obtained in gelatine, as far as my experience goes; that is, we can get a particular state in which it will answer to the vibration of rays of the lowest refrangibility. During five years this physical condition of silver bromide has occupied my attention, and, in my Bakerian lecture to the Royal Society for this year, I have fully described the means of producing this peculiar state of the bromide. It would be too long to consider this point here; it is sufficient to say that by preparing a very dilute collodion emulsion, in the first instance, with a large excess of acid, this physical state can be arrived at. I will show on the screen the kind of bromide usually obtained, and now I show the other variety, which is of a green-blue color. The one, by its color, we should guess, can only be sensitive to the blue and violet rays, and a little in the green, while the other ought to be sensitive to red, since a great deal of the red of the light is absorbed, and, where there is absorption, work of some kind must be done.

PHOTOGRAPHS OF THE INVISIBLE.

Here we have photographs of the solar spectrum, which have been taken on this salt. The limits of the visible spectrum lie between about wave length 39,000 and 76,000 tenth millimeters. The part I have photographed extends below the visible spectrum, and lies between 76,000 and 200,000 tenth millimeters, or we have photographed, with wave-lengths of radiation which lie more than three times below the red than the distance of the visible spectrum. The map I hand round is taken from measurement from photographs of the solar spectrum, made by means of a diffraction grating, and shows in detail their continuous spectrum from 76,000 and 10,500 tenth millimeters. Beyond that, at present, I have not mapped with this grating, as the light is very feeble at the best of times. With the prismatic spectrum, the limit reached is that already stated, viz., about 20,000 tenth millimeters. The application of this process is already bearing fruit. Major Festing and I are examining different colorless bodies, such as the alcohols and others and I doubt not, from what we have already got, that the chemist's view of compound radicals will be confirmed by results of spectroscopic analysis in the infra-red portions of the spectrum.

OXIDIZATION OF THE PHOTO FILM.

I have now to call your attention to the result of a research made on the undeveloped photographic image; and I trust that, in doing so, it may not be thought that I am speaking too much of my own work. My excuse is that I believe in time it will bear fruit in the hands of some one, and may greatly enlarge the scope of photography. The result obtained was that the photographic image, which is primarily produced on the plate by means of the splitting up of the silver salt into a lighter molecule, and some halogen, such as bromine or iodine, is rendered nondevelopable by means of oxidizing agents such as bichromate, permanganate of potash, hydroxyl, ozone, nitric acid, and so on. It matters not whether the image be produced on a collodion or gelatine film, or on paper, the result is precisely the same. The immersion of an exposed plate in an oxidizing solution will totally destroy the developing capacity of the image.

This oxidation of the image, I also proved, goes on in ordinary atmospheric conditions, more especially under the influence of light. Thus we have a simple explanation of what is known as solarization. You must picture to yourselves light acting on the salt, first to split its molecules up, into its components already indicated, and light still further acting, and causing the smaller silver molecule thus formed to become oxidized, and refusing to develop. The oxidation is best affected by the red rays and ultra-red. An examination of a solarized plate in most cases shows a decided "bluing" of the salt, which means that the red rays are absorbed, and can, therefore, do work upon them. Some careful researches showed that to this oxidation might be properly ascribed the reversing action of the red rays on the daguerreotype plate, so long ago described by Draper and

others, when, after a short preliminary exposure, it was placed in the spectrum. This was found to be the case, and the same result was produced with silver bromide in collodion—in the form sensitive to red light. This oxidation of the silver salt, which had been acted upon by light, caused me to try if the colored spectrum produced by Becquerel and Victor de Népce would be due to this cause. The results I have already communicated in a note to the Royal Society. The colors obtained under these circumstances are true pigments, and not the results of interference, as was formerly held; in fact, by transmitted light, when taken on collodion, the colors are as marked as when viewed by reflected light.

PLATINUM PICTURES.

Time flies so rapidly that it is necessary I should hurry on to printing processes, one of which is new in almost every particular, and which is absolutely permanent. Mr. W. Willis, Jun., found that he could obtain an image in platinum black, by means of development, if he sensitized his paper with ferric oxalate with which was mixed a solution of chloro-platinite of potassium. The action of light on this paper is to reduce the ferric salt to the ferrous state, and when the ferrous salt is in solution, the platinum salt is reduced by it. By floating the exposed paper on a solution of neutral potassium oxalate, which is a solvent of the ferrous oxalate, the platinum salt in contact with it is immediately reduced to the metallic state, and an image is thus built up. Through the kindness, and with the aid of Mr. Berkeley, of the Platinotype Company, I am able to demonstrate this process to you with effect. The sheets of paper have been previously exposed to light beneath a negative, and by floating them on a hot solution of the neutral potassium oxalate, the image at once flashes out. To fix the prints, they are immersed in dilute hydrochloric, which dissolves away any ferric oxalate there may be, and also gets rid of any oxalate of lime which may be formed.

The sensitiveness of this process is about four times that of the ordinary silver printing process, and this has enabled direct enlargements to be made by means of the electric light. The beautiful prints which you see on the wall are specimens taken in America, the time of exposure varying, I believe, between ten minutes and half an hour. These prints are purposely rather feeble, as they are meant to be a basis for working upon with the brush. To my mind, the platinum process is the greatest advance in printing that has been made for many years, and one great feature in it is its permanence.

FERRIC OXALATE PICTURES.

I have another printing process which I should also like to demonstrate to you, though it is in a somewhat imperfect state, and is waiting for some one to improve it. It is based on the reduction of silver bromide which has been exposed to light by ferrous oxalate, a discovery which is also due to Mr. Willis, and almost simultaneously by Mr. Carey Lea, of Philadelphia. This developer, I may remark, is often employed for gelatine plates, and for collodion emulsion plates. I know nothing better. It is an extremely vigorous developing agent, and gives wonderful black tones to a negative. Another advantage it has is that it does not stain paper permanently which may be immersed in it. A little diluted hydrochloric acid speedily clears the paper of all color, and leaves it in its pristine whiteness.

The process was one which gave me some trouble, as I wished to adapt it to the self-recording instruments used at Kew. After many experiments, with the details of which I will not weary you, it was found that by forming a bromide of silver in the pores of the paper, a print would be easily obtained. The paper is first immersed in a solution of soluble bromides and iodides, and, when dried, it is floated on a bath of silver nitrate, and then thoroughly washed. When dried, it is exposed behind a negative, twenty or thirty seconds to daylight being sufficient. It is next immersed in a weak solution of ferrous oxalate, and gradually the image is built up. The slower the development, the more the image is on the surface. A little sizing on the face of the paper would improve matters. When well washed, it is treated with a little dilute hydrochloric acid, and can then be toned with platinum, gold, iridium, and so on, any color up to a sepia color, being obtainable. The print is treated with dilute ammonia, and then fixed in hyposulphite of soda, and finally washed. As to the permanence of these prints, I believe it to be great, as there is no organic compound of silver, such as albuminate, which is really the great source of the deterioration of silver prints. We have nothing but metallic silver present, and the metal with which the tone is given. The elimination of the hyposulphites of soda and silver can be much more effectually carried out than with albumenized paper, as it is more porous. Calotype pictures fade less than albumenized prints, and hence I am hopeful regarding the permanence of the process. I may say that prints on a gelatinized surface, and on albumenized surface can be obtained similarly, and answer fairly well.

NEW MODE OF PHOTO-PRINTING.

At your meeting, when Mr. Spiller read his paper, he gave an account of the Woodbury process, and that I need not repeat now. It is sufficient to say that I hear of a modification of it introduced abroad by Mr. Woodbury, and another at home by Mr. L. Warnerke. Both these modifications consist in avoiding the necessity of resorting to hydraulic pressure to make the moulds from which the prints are taken. The present state of the process is this: a print from a negative is taken on carbo-gelatin tissue, and the image developed on a perfectly flat glass. When dry Mr. Woodbury, in his modification, covers it with tin or lead foil in a very simple manner. He makes this the bed of an electro deposit, and, after filling it in and backing with a proper backing, the gelatine matrix is removed, and the electro is then ready to be filled with liquid gelatine. Paper is next superposed, and the excess of fluid gelatine squeezed out by means of another flat surface placed over the paper. The gelatine, when set, adheres to the paper, and the print is removed and dried, giving a mechanical print, as by the old Woodbury method. Mr. Warnerke, instead of taking an electro, uses Spence's metal for making a cast, and prints from this cast. Either of these modifications will enable any and every photographer to print his photographs by this process without being dependent on any second party for their production. I look forward most hopefully to this simple method of mechanical printing, believing that it will materially alter the status of one branch of photography.

OTHER NEW MODES OF PHOTO-PRINTING.

The Autotype Company have kindly sent some specimens of their photo-mechanical printing, the details of which I need not describe, as it is not new; but the work turned out

from the printing press is now far superior to anything that has been done of late years.

Another printing process which is useful to engineers, architects, and those of like professions, is the ferro-prussiate process, which depends on the change of color of a mixture of a ferric salt, and ferriyanide of potassium, when exposed to light. The blue color so obtained is almost insoluble in water, and the unchanged sensitive salt is washed out by its immersion in water. I have to thank Messrs. Marion & Co. for these specimens, which I now show.

Mr. Warnerke has kindly lent me, for your inspection, samples of his photo-engraving process on copper; finer specimens I have never seen. We have first, the original engraving; second, the photo-engraved plate; and third, the impression from such a plate. It is impossible almost to distinguish the reproduction from the original. The process used is, I believe, an asphaltum process, and certainly gives most excellent results. We shall probably learn more about the process in the future.

An adaptation of another material to photography deserves passing mention. At the last meeting of the Photographic Society, Mr. Warnerke and Lieut. Darwin, R.E., both showed examples of the mode of utilizing a luminous image taken on a phosphorescent plate in the camera, or by allowing light to pass through a negative on to it. A surface so impressed is simply put in contact with a sensitive plate for a few seconds, and the image developed. I pass round some examples kindly furnished by Lieut. Darwin.

Another adaptation of phosphorescence is to the formation of a photometer. The stronger the light acting on a phosphorescent surface, the brighter it glows in the dark, and Mr. Warnerke has shown that the intensity of the incident light can be readily ascertained by finding what thickness of semi-opaque material extinguishes to the eye the luminosity of the phosphorescence. On this he has based a new actinometer for use by photographers, and since the radiations existing in daylight, and which are principally active in impressing the photographic image, are nearly the same as stimulate the phosphorescent material used, the principle is correct, and is an advance in the right direction, more particularly as the actinometer is not dependent in its action on any particular time for exposure of the sensitive surface to light. Where rapid plates are employed, an actinometer is absolutely essential. The completed instrument and its component parts I hand round for inspection.

PHOTOGRAPHY IN NATURAL COLORS.

I cannot but feel that what I have so rapidly sketched has been imperfect, but I have done my best in the time at my disposal. In looking to the future of photography, I see several goals to aim at. The first is photography in natural colors, regarding which I am more sanguine than most. There is no theoretical objection to it. It has been objected that the retina and a photographic plate are very different media, and that what appears as color to one appears as something different on the other. Well, though I agree to the difference of material, I agree to nothing else. Absolute experiment has shown that true colors can be produced, and that the colors so produced are true pigments. If they can be obtained in the spectrum, they ought to be obtained from colored objects—and even this has been done—and when increased sensitiveness is obtained, there will arrive a time when anything and everything can be impressed in its own coloring. A less difficult goal to aim at is to give local intensity to gelatino-bromide negatives; and the third, to obtain even better printing processes than already exist; and my thoughts naturally turn to the platinum process for a further advance.

SEEING BY PHOTOGRAPHY.

Regarding the diaphote, telephoto, or whatever you like to call it, I am very despondent. I believe that this kind of photography is an impossibility, for the reason that one wire can never carry an infinite number of electrical impulses, which on reconversion into chemical energy shall give various gradations of light and shade simultaneously on a surface. The ethereal vibrations giving us what we call light are unconstrained, and vibrate on the whole of an exposed surface. These vibrations, when converted into electrical waves, have to vibrate in a wire; hence, I see no possibility of success. A multiplicity of conducting wires is evidently impossible, if accuracy be required. The best that can be hoped for, it seems to me, is that a print in silver or carbon, placed at one end of a wire, may be reproduced at the other by some method which will closely approximate to Banes's system of telegraphy. I again assert that—as far as we can see by the eye of science at present—there is no probability of an image, reflected in a mirror at one end of a wire, being reproduced at the other end at one operation. Anything short of this would not be true telephotography.

DISCUSSION.

Mr. John Spiller said it was a great pleasure to him to find that Captain Abney had so long a list of novelties and discoveries to bring forward, which had been developed in the brief interval since he read the paper to which allusion had been made; in fact photography might be said almost to wear a totally new complexion. The platinotypes exhibited on the wall were very beautiful, and yet the process was only in its infancy. The platinotype of the day when he had the honor of addressing them was only a mixture of silver and platinum, as to the permanence of which there might be a question; but in the finished results brought forward that evening, they might recognize the platinotype as a perfect record, which offered promise, at any rate, of very great permanence, and as far as his chemical knowledge went, it must be regarded as a true permanent process. The novelties now brought forward were of two kinds—improvements in old processes and new discoveries. He was glad to hear from Mr. Warnerke's hopeful results of further improvements in the Woodburytype process, also to find that the autotype process was still making advances, and that in many ways old processes were moving forward; but he was still more encouraged to hear of a whole list of new directions of research in which Captain Abney himself had had the principal hand. Perhaps to no one in England were they more indebted for several new and promising researches. Many of them had already borne fruit, and he felt certain that in the future some grand results would arise out of the interesting researches which had necessarily been only briefly alluded to that evening. The establishment of a more satisfactory system of photometric record was of considerable importance. They found from the day's papers that on the previous day the sun shone only half an hour. That day it had been shining all the morning, succeeded by an afternoon of a curious hazy, yellow light, which must have given photographers some trouble. That was obvious to the eye, but he looked forward to the establishment before long of a truly scientific method of photometric record, by which the

would know for certain what were the qualities of the rays which reached the surface of the earth, and the duration of the sunshine. The only other point he would allude to—and that he thought might be left in the hands of the chairman to refer to—was the possibility of producing photographs in colors. It was a subject to which he had given considerable attention, and he was sure the meeting would like to hear Mr. Lockyer's opinion on the possibilities of the case. In common with many photographers he had seen the results shown many years ago, but as yet it must be acknowledged that photography in colors only existed in the future.

A member suggested that photography, especially now that it had become almost instantaneous, might be of great service in connection with medical and surgical science, in preserving an exact record of the appearance, either of diseased parts, or of the general appearance of a patient, say after a railway accident or in hospitals.

The Chairman said it seemed to him a matter of exceeding importance that practice and theory went so closely hand in hand in this particular branch of work, and it was to be hoped, not only that Captain Abney would go on with increased vigor along the magnificent path he had chalked out for himself, but that others would step in and try to emulate him, and for the sake of science, the sooner they did so the better. Some few years ago, when giving a course of lectures in that place on a similar subject, he had to point out how the science of spectroscopy was indebted to photography, inasmuch as by its aid they secured permanent records of the various phenomena it was essential to investigate, and he then ventured to prophesy that although photography had then done a great deal to help spectroscopy, the time would come when spectroscopy would do a little to help photography. Thanks to Captain Abney that prophecy was already being fulfilled, for most of his results had been tested, so to speak, by application to the spectrum, either at one end of it or the other. And looking back to the old records, reading those wonderful papers of Draper's and Herschel's, printed between the years 1837 and 1843, and the diagrams in connection with them, it really seemed a pity that so much time should have been lost; it was enough to fill the most ardent student with dismay, that what seemed now so clear and simple, because whole fields of science had been investigated since then, should have taken so long a time to discover. With regard to the future of photography especially in the direction to which Mr. Spiller referred, he should be daring enough again to utter a prophecy. He was quite certain that photography had yet very much more to acquire from a careful study of the spectrum than it had gained already. He believed that spectroscopy would before long show those who cared to study it, especially in connection with photography, that the idea that there could be any impossibility in obtaining natural colors on a photographic plate was perfectly absurd, and arose only from our ignorance of the human eye. Since those lectures of his were delivered, some of the most important advances had been made touching human vision, which were chronicled in the history of science; he referred to the magnificent work of Krönig. If you read between the lines of the work you would see that all the work of the human eye was done by two, or possibly three, different sets of molecules. They had already become familiar with the idea from Captain Abney's paper, with molecules which absorbed in the red, and those which absorbed in the blue, and so on; in other words photography had advanced from a merely chemical to a purely physical standpoint; and when they got the purely physiological standpoint put as clearly as the physical standpoint was now being put, photography in colors would be one of the simplest things, both to imagine and achieve, which men of science could achieve. Another thing which must strike every one was that, as these molecular studies advance, photography would be founding new branches of chemistry in directions where, at present, very little was done. Why should they limit themselves to silver? If these molecular groupings which you got in silver were real, depend upon it their homologues existed in connection with every other chemical element and chemical compound. Not being a practical photographer he did not know these matters in detail, but if there was any objection to silver, no doubt copper would do as well. He had little doubt the time would come when photography in copper would be quite possible; whether it would be desirable was, of course, another matter. The point of his remarks, however, was that photography was going on hand in hand with physical science, and the two advancing side by side along the road, they were bound, in the long run, not only to make the art much more beautiful, but to make the region of pure science a pleasure and delight to every one who looked at a photograph.

Lord Alfred Churchill, on the part of the Council of the Society, begged to thank Captain Abney very much for his excellent paper and charming illustrations. He was not competent to speak on the scientific aspect of the question, and therefore would not attempt it. It was true that some years ago he studied photography a little for his own amusement, but that was in days of the wet process and dirty fingers, and consequently he gave it up, but he felt very much inclined to take it up again under this new process of dry plates. He was very glad to hear so confident an opinion expressed both by Captain Abney and the chairman, that photography in colors was probable.

The vote of thanks having been passed, Captain Abney said he had only one duty to perform, and that was, to ask the meeting to thank the gentlemen who had so kindly rendered him their assistance by sending specimens, viz., Mr. Barclay, Mr. Warnerke, Mr. Gale, and Mr. England.

LAW OF WISCONSIN AGAINST FOOD ADULTERATIONS.

THE following is an act passed by the State of Wisconsin: An act to prevent the adulteration of food and medicine, and provide for analyzing the same. The people of the State of Wisconsin, represented in Senate and Assembly, do enact as follows:

Section 1. The Governor of the State shall appoint one of the professors of the State University of sufficient competence, knowledge, skill, and experience, as State analyst, whose duty it shall be to analyze all articles of food or drink, and all drugs and liquors manufactured, sold or used within this State, when submitted to him as hereinafter provided. The term of office of such analyst shall be three years from his appointment, unless sooner removed by the appointing power, and his compensation shall not exceed two hundred dollars in addition to his annual salary as professor, and shall be paid by the board of regents of the State University, from the university fund.

Section 2. The State Board of Health and Vital Statistics, medical officers of health, inspectors of weights and mea-

sures, boards of supervisors of any town, boards of trustees of any village, aldermen or common council of any city in this State, or a majority of said corporate bodies, may, at the cost of their respective corporations, purchase a sample of any food, drugs, or liquors offered for sale in any town, village, or city in this State, in violation of sections number one, two and four of chapter two hundred and forty-eight of laws of A. D. 1879, or if they have good reasons to suspect the same to have been sold or put up for sale contrary to the provisions of said chapter two hundred and forty-eight, may submit the same to the State analyst as hereinafter provided, and the said analyst shall, upon receiving such article duly submitted to him, forthwith analyze the same, and give a certified certificate to such person or officers submitting the same, wherein he shall fully specify the result of the analysis.

Section 3. Any person purchasing any article with the intention of submitting it to an analysis, shall, after the purchase shall have been made and completed, forthwith notify the seller or his agent selling the same, of his or their intention to have the same analyzed by the State analyst, and shall offer to accompany the seller or his agent with the article purchased to the town, village, or city clerk of the place in which the article was bought, and shall forthwith remove the article purchased to the office of said clerk, and in the presence of the seller or his agent, if present, divide said article into two parts, each to be marked, fastened, and sealed up in such a manner as its nature will permit. The said clerk shall forthwith forward one part to the State analyst by mail, express, or otherwise, as he shall elect, and shall retain the other part or package subject to the order of any court, in which proceedings shall thereafter be taken. The certificate of the State analyst shall be held in all the courts of this State as *prima facie* evidence of the properties of the article analyzed by him.

Section 4. If any person applying to purchase any article of food, drug, or liquor exposed for sale or on sale by retail on any premises in any town, village, or city in this State, and shall tender the price of the quantity which he shall want for the purpose of analyzing, not being more than shall be reasonably required, and the person exposing the same for sale shall refuse to sell the same, such person so refusing to sell shall be liable to a penalty not exceeding fifty dollars.

Section 5. The State analyst shall report to the State Board of Health and Vital Statistics the number of all the articles analyzed, and shall specify the results thereof to said board annually, with full statement of all the articles analyzed and by whom submitted.

Section 6. The State Board of Health and Vital Statistics may submit to the State analyst any samples of food, drugs, or drink for analysis as hereinbefore provided.

Section 7. This act shall take effect and be in force from and after its passage and publication.

Approved March 15, 1880. (Published March 26, 1880.)

[Continued from SUPPLEMENT No. 221, page 3024.]

PROGRESS OF INDUSTRIAL CHEMISTRY.

BRIEF REVIEW OF THE MOST IMPORTANT CHANGES IN THE INDUSTRIAL APPLICATIONS OF CHEMISTRY WITHIN THE LAST FEW YEARS.

By J. W. MALLETT.

MATERIALS USED AS FOOD.

Bread.—Probably the most valuable aid has been rendered to bread-making by the careful manufacture on a greatly increased scale of pressed yeast, which improved means of rapid transportation have permitted to be sent in still fresh and sound condition to an ever enlarging circle of consumers. In this country, more than elsewhere, the use of various "baking powders" prevails, intended to produce carbon dioxide throughout the mass of dough, thus rendering it spongy. Of these preparations two require mention besides the long used cream of tartar and bicarbonate of soda; namely, the acid calcium phosphate (with some alkaline carbonate and a little potassium chloride) of Horsford, now largely and advantageously employed, and the dried ammonium alum with sodium carbonate which has for the last few years been extensively sold, but with very doubtful advantage on the score of wholesomeness.

Meat.—In view of the conditions under which the animals most used for food must be reared, most cheaply at great distances from the dense population by which they will chiefly be consumed, one of the most important of modern industrial problems is that of meat preservation. On the whole, the first place among the many recent attempts at a satisfactory solution may fairly be given to the process of "canning"—exposure of the meat in suitable vessels, practically cylinders of tin-plate, to a temperature high enough to destroy the vitality of organized ferments, and to expel most of the air from the unoccupied part of the vessel, followed by effectual exclusion of the atmosphere by sealing hermetically with solder. The method may be called recent, since, although fully worked out by Appert as early as 1796-1804, it remained but little used until some fifteen or twenty years ago as compared with its great extension at the present day. It is needless to say that this process is also most useful in its application to fish, milk, vegetables, and other forms of perishable food.

Another mode of preserving meat in fit condition for use, excellent in its results, but formerly difficult to carry out in practice, namely, the maintenance of the flesh at a temperature not much above the freezing point, has been brought much more under control by the numerous machines for the production of artificial cold. Although success has attended this plan as applied both for sea and land transportation, the latter commonly with the aid of natural ice, it doubtless admits of being developed upon a larger scale in the future.

Of lately introduced chemical agents to be used as preservatives the most prominent have been salicylic acid and boracic acid or soluble borates. The former, economically manufactured from phenol by Kolbe's synthetic process, is an efficient antiseptic, but limited in its application to meat by its disagreeable taste and the irritant effect it produces upon the fauces when used in needful quantity. The tastelessness of boracic acid, and of the acid phosphates, whose production by its means is, according to Endemann, the chief source of its utility, constitutes an advantage in its favor, but the question of possible danger to health from long continued ingestion of boracic acid or its salts cannot be said to have yet been satisfactorily settled.

Meat Extracts.—Besides the use upon a much larger scale than formerly of meat extract made by Liebig's original process, the introduction is to be noted of analogous pro-

ducts differing therefrom in retaining the animal albumen in uncoagulated form, the evaporation being carried out at temperatures never allowed to reach 60° C. Valentine's "meat juice" represents one of the most carefully prepared of these materials. The process of Leube, published some years ago, involves still another idea, that of bringing into solution the whole of the albuminoids, including the solid muscular fiber, by digestion of the lean meat under pressure with water containing a little hydrochloric acid, neutralizing the free acid with sodium carbonate, and evaporating cautiously to extract consistence. This plan does not seem to have come into general use, nor has any definite reason been given for the failure to employ it.

Preserved Vegetables.—The extensive application of the Appert system of "canning" to fresh vegetable food, tomatoes, peas, young Indian corn, and the like, has been supplemented by the process of desiccation, admirably carried out by Chollet & Cie., of Paris, among other firms. The vegetables to be thus preserved are exposed for a short time to the action of steam under considerably more than normal pressure, then rapidly dried in a current of warm air, and finally pressed hard into cakes under a hydraulic press. As an addition to a soldier's ration, these cakes deserve attention from their wholesomeness, the very fair degree in which the fresh odor and flavor are retained for a considerable time, and the convenient form presented for transportation. The now celebrated *Erbnourist* of the Franco-Prussian war involves the principle of desiccation along with that of admixture with fat, but is chiefly noteworthy on the ground of its supplying albuminoid food from a vegetable source and in concentrated and portable form. Desiccation alone has also been usefully applied to eggs, the yolks and whites of which, carefully dried at a low temperature, can long be preserved in fit state for use in cooking.

Butter and Cheese.—The manufacture of these milk products has, notably in some parts of the United States, tended of late years to pass from domestic hands, as a simple farm industry, into those of firms occupied exclusively with dairy operations, the work being carried on in large factories, fitted up with special plant, and supplied with engine power. The minute details of the manufacture, exact attention to temperature, exclusion of ferments, etc., are looked to with much more care in such establishments than they can well be in private hands.

The "artificial butter," "oleo-margarine," or prepared beef fat of Mourie's, has come into use on a very large scale, and, notwithstanding the prejudice aroused against it by its fraudulent sale as actual butter, it must be counted as a not unwholesome, and under some circumstances a valuable addition to the food resources of the world, it being assumed of course that the manufacture itself is honestly carried out with sound material to work upon.

Sugar.—This important manufacture has in its various stages undergone sundry modifications. In some of the regions of production, both from the juice of the cane and from that of the beet, there has been an extension of the practice of making a more or less refined product directly from the crude material, but in general the tendency has been rather in the opposite direction, to a distinct separation of the business of making raw sugar by simple means from the juice, and that of refining this raw sugar for the superior purposes of consumption. Even further subdivision of the industry is largely practiced; many producers of beet-roots confining themselves to rasping them to pulp and pressing out the juice, to be sold at a stipulated rate to the sugar-makers proper, and sent to them by means of underground pipes, hundreds of miles of which on the Linares system have been laid in Northern France and in Belgium; while, at the other end of the process of manufacture, the working up of molasses and refinery sirups is often found in other hands than those of the first makers of crystallized sugar with whom they have originated.

The success and actual distribution of the sugar industry in different parts of the world, in whatever form conducted, has varied much from time to time, as in the case of Russia, where the extension of production from beet-root has been wonderfully rapid, and in Austria, where the same industry has notably fallen off; everywhere the influence of tariff and internal legislation has had much to do with modifying the effects of natural conditions and of the progress due to improved methods of production.

In obtaining the juice from beet-root the older use of hydraulic presses has been largely superseded by the more modern cylinder presses, and of late the horizontal direct-acting filter presses have been used with advantage, both as to the amount of juice obtained and its degree of freedom from fine fragments of vegetable fiber.

The diffusion process, by which thin slices of the fresh root are exhausted of sugar by successive portions of water, has become firmly established in many factories, avoiding the use of costly machinery and much engine power, furnishing a purer juice than that obtained by expression, and in consequence of the systematic use of the water in the successive cylinders of the diffusion battery not seriously increasing the consumption of fuel for evaporation. It is much to be desired that the same process should be generally extended to the extraction of juice from the sugar cane; the feasibility of this having been fairly established by experiments on the full working scale with the apparatus of Robert; no other method seems so likely to remedy the enormous loss of juice, fully one-third of the whole, now experienced in the ordinary mill crushing.

For the purpose of rapidly reducing cane juice by evaporation to the condition of a solid mass, capable of being kept without material alteration and shipped to distant points for manufacture into salable sugar in the hands of the refiner, the simple and effective apparatus known as Fryer's concretor deserves special attention; already considerable quantities of "concrete" made with it have been shipped from West Indian and South American ports with satisfactory results, both to the sugar planter and refiner.

In the clarification of the juice from beet-root the chief recent modification has been the use of largely increased quantities of lime, to be afterwards removed by a current of carbon dioxide gas as usual, the much larger amount of scums and sediment thus produced proving manageable with the aid of the improved filter presses; saving of bone-black in the subsequent filtration may thus be effected.

The kilns for charring and revivifying the bone-black used in the decolorizing filters have been improved in various points of detail as to construction, method of working, and durability. Decolorization by bone-black has come more frequently into use on plantations making white sugar directly from cane juice, as in some districts in Cuba.

The vacuum pan for evaporation of the juice is also more often to be seen as a portion of the equipment of plantation sugar-houses. In boiling down the juice, whether of cane

or beet, the practice has become more common of crystallizing much of the sugar in the vacuum pan itself before transference of the mass to the coolers.

In regard to the crystallization and drainage, although the old fashioned loaf sugar is still made, loose crystals drained and washed in the centrifugal machine have assumed much greater importance, and the former practice of crushing or cutting up loaf sugar into fragments of convenient size to be used in tea, coffee, etc., has been reversed, lumps being now moulded by pressure from loose granular sugar in fine crystals.

In recovering an additional amount of crystallizable sugar from the molasses of first drainage the process of most importance is that of dialysis through parchment paper, to recover much saline matter by osmose before a second crystallization, as originally proposed by Dubrunfaut. The liquid from the water cells of the dialyzer is either fermented and distilled to recover such small amount of sugar as it contains, or is simply evaporated to dryness and the saline residue utilized as manure. Less in use than this, but yet practically employed by a good many factories, is the process for separation of sugar from molasses as sugar lime, washing with alcohol.

In the distinct industry of making starch sugar, the consumption of which by brewers, manufacturers of factitious wines, table sirups and caramel, and in the adulteration of the cheaper grades of brown sugar, has assumed very large proportions, less water is used than formerly and very little acid, but the process is conducted in close vessels under pressure sufficient to allow of the temperature rising to as much as 160° C. The product is to be found in the form of a granulated crystalline mass, in solid blocks, and as a thick, highly viscid sirup, the last containing much dextrose.

Wine.—The manufacture of this, as of all other alcoholic beverages, has been placed upon a more rational basis by the valuable researches on fermentation of Pasteur, Liebig, Rees, Brefeld and others.

Chemical materials have been employed to combat the diseases of the grape-vine in Europe due to fungoid and insect attacks. It seems still doubtful whether the former of these two sources of injury is capable of being reached by sulphur itself, or only by the acid products of its oxidation; if the latter be the case there is enormous waste of material in the flowers of sulphur actually in use.

The most distinctly novel step in modern wine-making itself is doubtless Pasteur's process for destroying organized ferments in the bottles or other close vessels used to finally contain the wine, by heating for half an hour or an hour to 60° or 70° C. Valuable as is this process in principle, it requires care in practically carrying it out, and its use has been restricted in France by the liability to injure the delicate bouquet of the finer wines in applying this method to their preservation.

Much so-called chemical skill is ill bestowed upon the fraudulent practice of wine fabrication and adulteration, although it is perhaps more difficult in regard to this than to most other industries to draw the line between adulteration and legitimate variations of ordinary practice, as for instance the use of clarifying materials and special forms of tannin, the employment of plaster in the vats, etc.

Beer.—As an addition to wort made from simple malt, glucose and dextrose made from starch by boiling with dilute acid have come into extensive use.

O'Sullivan and Valentine have introduced an analogous material containing maltose instead of glucose, made by the action of dilute sulphuric acid upon ground rice under carefully regulated conditions of time and temperature, the solution obtained being neutralized with chalk, filtered and evaporated in the vacuum pan to a cake consisting of two-thirds maltose and one-third dextrose. Glycerine is also very largely employed as an addition to the wort, serving to sweeten and give consistence to the beer and to moderate in some degree the fermentation.

In boiling the wort hop-extracts have of late to some extent taken the place of actual hops. It is said that these extracts are often made with light petroleum naphtha as the original solvent.

Pasteur has applied his views of fermentation to the proper cooling of the wort by proposing that, immediately after boiling, it be run off into close vessels, and that in these it be kept covered by a stratum of carbon dioxide drawn from the fermenting vats until it has been cooled down to proper temperature, yeast added and fermentation fairly set up. In the rapid cooling of the wort when contact with the air is not cut off, advantage has been taken of the modern ice machines to produce the required reduction of temperature; some of the forms of such machines less adapted to the actual production of ice, as that worked with air alternately compressed and expanded, answering very well for this purpose, with its moderate cooling of very large masses of liquid.

As affording the means of regulating the fermentation, by the addition of a very small quantity of foreign material without objectionable effect upon the taste of the beverage, salicylic acid has been proposed by Kolbe and to some extent used.

Pasteur's heating process has been found equally effective for the preservation of bottled beer, such as is largely sent to warm climates, as for that of wine.

Distilled Spirits.—The manufacture of spirit from potatoes has undergone great expansion, especially in Central Europe, while the increase of beet-root production has in various countries, particularly in France, led to a corresponding increase in the distillation of alcohol from the residual molasses.

In making potato spirit the practice has been introduced of rapidly steaming the potatoes under increased pressure, then reducing the pressure to the normal point, rapidly cooling and adding malt for the digestion which is to convert the starch into glucose.

The stills in use are continually improved in their minor details, but with no very recent novelty of importance in the principles of their construction.

One of the most interesting modifications of the system of beet-root spirit distillation has been the new method proposed and worked out by Camille Vincent, for utilizing the *vinasse* left behind in the stills. He evaporates this liquor, and submits the residue to destructive distillation in iron vessels (instead of burning off organic matter in the open air). The black porous material found in these vessels is then leached for potash. The condensable portion of the distillate consists of ammoniacal liquor and tar. From the former of these the novel products of tri-methylamine (along with other amine bases) and, from it, methyl chloride are made—this methyl chloride for use in ice machines, in the extraction of perfumes, and in the coal-tar color industry.

The tar yields bases of the pyridine series, for which it is not impossible that a use may ere long be found; a single large distillery at Courrières turns out daily, besides other by-products, 100 kilos of methyl alcohol and 1,800 kilos of concentrated solution of salts of tri-methylamine.

Vinegar.—Among the results of Pasteur's investigations of organized ferments has been the practice, made use of in France on an industrial scale, of hastening the usual course of acetic fermentation by transplanting or sowing the vinegar *mycoderma*.

In the German, so-called quick method of vinegar making by filtration of the alcoholic fluid through a mass of porous material, usually wood shavings, this mass being traversed at the same time by an ascending current of air, the importance is better recognized now than formerly of carefully regulating not only the temperature but the rate of supply of the liquid to be acidified and the air, since without attention to this notable losses of material may occur, on the one hand by imperfect oxidation and the formation of aldehyde, on the other by more than inevitable evaporation, and by excessive oxidation to carbon dioxide and water.

Artificial Flavoring Essences.—For some years there has been an extensive manufacture of ethers to be used as flavoring materials for confectionery, soda water and other sirups, etc. Those most largely made are the ethyl and amyl formates, acetates, butyrates, and valerianates, but ethyl pectonate, methyl and ethyl salicylates, and others are also produced.

The most interesting additions of late to the list of such products have been benzoic aldehyde (artificial bitter almond oil), from coal tar toluene, converted by the prolonged action of chlorine into benzyl chloride, to be distilled with an alcoholic solution of an alkaline hydrate; allyl isothiocyanate (black mustard oil) from glycerine, distilled with crystallized oxalic acid so as to yield allyl alcohol, and the alkaline thiocyanates so readily obtained as waste products of the treatment of the ammoniacal liquor of gasworks; and artificial vanillin ($C_8H_8O_3$) procured by Tiemann and Haarmann's process from coniferine ($C_{15}H_{18}O_4$), converted into coniferyl alcohol ($C_{11}H_{14}O_2$) with assumption of the elements of water and elimination of glucose, and then oxidized by chromic acid mixture. The high price of the natural vanilla, and its extensive use in connection with chocolate, liqueurs, confectionery, bonbons, etc., gives special importance to the artificial production of its essential constituent.

Artificial Mineral Waters.—These products, occupying a somewhat doubtful position between the ordinary accompaniments of food and therapeutic agents, form the basis of quite an extensive industry, which has grown to its present magnitude within but a few years. With the long-used carbonic acid water as a starting point, numerous effervescent waters containing also saline ingredients are made, and omitting the gaseous impregnation, various natural waters, saline, chalybeate, etc., are imitated more or less closely, while of late the artificial modification of the natural contents of certain mineral springs has, with disputed propriety, been added to the directions in which this industry is pushed forward.—*American Chemical Journal*.

THE AMERICAN CHEMICAL SOCIETY.

The regular meeting of the society was held on Thursday evening, June 3, 1880, at University Building, Washington Square. Dr. Albert R. Leeds, Vice-President, in the chair.

Mr. Alexander Cochrane, of Boston, Mr. Hugh Cochrane, of Boston, and Mr. Lucius Pitkin, of New York, were elected associate members of the society.

The following gentlemen were nominated:

As Members.—Herman Poole, Buffalo, N. Y.; Dr. Karl Stahl, Tacony Chemical Works, Philadelphia; G. T. Bihn, Philadelphia; C. H. Torrey, School of Mines, Columbia College, New York.

As Associate Members.—Thomas Harrison, Philadelphia; J. R. Savage, Philadelphia.

It was resolved that the society should have a meeting, either formal or informal, in Boston, during the session of the American Association for the Advancement of Science, and that the First Vice-President should appoint five members of the society as a committee to carry out this resolution.

A paper on "Some New Coloring Matters Produced by the Action of Diazo-Compounds on Phenols" was read by Mr. Jas. H. Stebbins, Jr., S.B.

The first part of the paper was devoted to a history of the discovery and development of the diazo-compounds, beginning with the work of P. Griess, in the year 1857, and running rapidly through a number of interesting and valuable researches down to the present time.

Mr. Stebbins then went on to describe a number of new bodies produced by himself, and which are very interesting contributions to this wonderful series of chemical compounds.

The first of the bodies described was azobenzol-trinitro-oxybenzol, made by the action of picric acid on diazobenzol-nitrate. This body is very explosive when heated.

Azobenzol-pyrogallol was next described. It is made by the action of pyrogallol on diazobenzol-nitrate; crystallizes in red-brown needles, slightly soluble in alcohol, and in this form it is adapted for dyeing.

Another body was para-azobenzol-sulpho-phloroglucine, made by acting upon diazo-sulphuric acid with phloroglucine. This compound forms a soda-salt, easily soluble in water, and also an acid-barium-salt, less soluble in water than the soda-salt.

The next body described was azobenzol sulpho-cresol, made by acting upon diazobenzol-nitrate with cresol-sulpho-acid. It crystallizes in long, red-brown needles with metallic luster, soluble in alcohol and less so in hot water.

The above compounds had already been described by Mr. Stebbins in a previous communication to the society, but he thought it best to review them and add some new facts. He then went on to describe the new dyes, the results of his recent researches.

The first of these new bodies was dinitro-oxyazobenzol-ortho-oxy-sulphobenzol, a compound intermediate between Griess' azo-sulphobenzol-ortho-nitrophenol and Mr. Stebbins' azobenzol-trinitro-oxybenzol; and it may be made from diazo-dinitrophenol and phenol-ortho-sulpho-acid. It crystallizes in yellow-brown needles with metallic luster, sparingly soluble in hot and cold water.

Another new body, made by Mr. Stebbins, is azo-naphthalin-sulpho-ortho-nitro-oxybenzol, which is similar to Griess' azo-sulphobenzol-ortho-nitrophenol. It is produced by treating diazonaphthionic acid with ortho-nitrophenol, and forms red-brown microscopic needles, very soluble in water.

Up to the present time no attempts have been made to combine more than two sulpho-groups (HSO_4) in one compound. It occurred to Mr. Stebbins that possibly three such groups might be combined, and, with this point in view, the following body was produced:

Para-azo-sulphobenzol-beta-oxydisulphobenzol-naphthalin. This body can be produced by several methods, but the simplest of these is by combining naphthol-disulpho-acid with diazo-sulphanilic acid. The free acid of the new compound crystallizes in pretty orange leaflets with beetle-green luster, soluble in water, with an orange color. A lead-salt of this compound was formed, giving a yellow powder, soluble in water.

The next body described was azo-benzol disulphonaphthol. It is made by treating the soda-salt of beta-naphthol-disulpho-acid with diazobenzol-nitrate. This body forms both soda and barium salts, the former very soluble in water and the latter only sparingly soluble in that liquid.

By combining diazotoluol nitrate and beta-naphtholdisulpho-acid there is formed para-azo-toluol-beta-naphtholdisulpho-acid. It is a fine scarlet dye. The free acid forms red-colored leaves, very soluble in water. The soda-salt is very soluble in water, and the barium-salt is only sparingly soluble in that liquid. Mr. Stebbins stated that he had made the ortho and meta compounds of this last body in the same manner as the para compound just described, and that they resemble it more or less, giving only different shades of color, one more yellow and the other more red. These last are also scarlet dyes, soluble in water.

Para-azo-sulphobenzol-naphthalin-resorcine was produced by treating diazonaphthionic acid with resorcine. The free acid of this body gives dark-brown needles, very soluble in water.

The last compound described was parazodibrom-sulphobenzol-beta-naphthol, obtained by allowing parazodibrom-benzol-sulpho-acid and beta-naphthol to act upon one another. The free acid is pretty soluble in hot water.

This highly interesting paper was illustrated by a number of samples of silk dyed with the new colors, whose richness and beauty of shade caused them to be much admired.

In the discussion which followed Mr. Stebbins said that he would resume his researches in the fall, when he hoped to be able to finish some of the minor details of the paper. He also remarked that many of the new dyes were faster than aniline dyes.

Dr. Leeds read a paper "Upon the Action of Light and Darkness on Standard Tannin Solutions." In the previous communication the author had reviewed the labors of Schlossing and Muntz upon the dependence of nitration upon the presence of an organized ferment, and of R. Warrington upon the necessity of darkness to the development of the nitrifying body. The amount of ammonia converted into nitrous acid, under the action of a fungoid growth in a standard solution of ammonium chloride placed in the dark for a considerable period, had also been given. In this communication the author stated that similar ammonium chloride solutions, from which, however, oxygen was excluded, did not change under the influences of a fungoid growth, in light or darkness, and with or without chloroform. Tannin solutions containing saproleginous growths, and to which the access of oxygen was permitted, changed little in diffused light, but to a great extent in the darkness; the development of fungi being large, and the percentage of tannin, diminishing during the lapse of eighteen months as much as eight per cent. The presence of chloroform in the latter case retarded, though it did not prevent, the fungoid growth. The conclusions drawn from the experiments narrated were that the circumstances most favorable to the indefinite preservation of standard solutions of this character are exposure to light, exclusion of air, and the absence of germs of fungoid growth.

Dr. Leeds also presented a memoir "Upon certain New Methods in Actino-Chemistry, with their Application to the Sun, Electric and Magnesium Light, and to the Actino-Chemical Analysis of the Atmosphere."

The results obtained in three previous communications made to the society in the year 1878 and the spring of 1879 were summarized, and the confirmation of the laws then announced, which govern the rate of change of the soluble iodides in the presence of actinic rays and of dilute acids, was afforded by the results subsequently obtained by the use of chemically equivalent solutions of iodides and acids. The amount of iodine set free in the presence of hydrochloric acid in the sunlight was shown to be greater by a definite ratio than that liberated by sulphuric acid, whatever might be the nature of the iodide employed. The amount of decomposition effected by heat, the electric and magnesium light was also given, and the relative amount of absorption of the actinic rays emitted from these sources, when passed through absorbing media.

ON THE CHEMICAL COMPOSITION OF PYROXYLINE AND THE FORMULA OF CELLULOSE.

TETRA-NITRO CELLULOSE, $C_{12}H_7O_{14}(NO_2)_4$, and TRI-NITRO CELLULOSE, $C_{12}H_7O_{13}(NO_2)_3$, always form together when collodion cotton is prepared, provided the acids are not too concentrated and are warm enough. I shall quote a few examples:—

1. The pyroxyline, produced by the treatment of cotton with a mixture of one volume of sulphuric acid (=1.43) and one volume of nitric acid (=1.38) for five or ten minutes at 65° C., had the following composition:—

Computed Composition of Tetra-Nitro Cellulose.			
	A	B	C
C	28.10	—	—
H	3.23	—	—
N	—	11.41	11.51

The composition thus approaches that of the tetra-nitro; but the compound is not perfectly pure. It is perfectly soluble in the mixture of ether and alcohol.

2. Cotton treated at 80° C. for fifteen minutes with a mixture of equal volumes of sulphuric acid (=1.845) and nitric acid (=1.40) gave a pyroxyline having the following percentage composition:—

Computed Composition of Tetra-Nitro Cellulose.			
	A	B	
C	27.90	—	
H	3.33	—	
N	—	11.06	

To this class belongs Schering's collodion cotton, which has the composition of the tetra-nitro.

3. A mixture of 80 c.c. of nitric acid (=1.38—1.39) and 100 c.c. of sulphuric acid (=1.845) gives at 65° or 70° C. a short-fibered pyroxyline. If too much cotton be used it will be destroyed. The action lasted from five to ten minutes.

The product contained 10-12 per cent. N, and was, therefore, a mixture of tetra-nitro with a great deal of tri-nitro.

I was not successful in separating the tetra-nitro from the tri-nitro, though they showed a distinct difference in their behavior. The tetra-nitro (or, more properly, collodion cotton rich in tetra-nitro) is insoluble in pure alcohol or in pure ether (even warm), while it dissolves with ease in a mixture of ether and alcohol, acetic ether, wood spirit, a mixture of acetic acid and alcohol, and a mixture of acetic acid and ether. In cold glacial acetic acid it is scarcely soluble, and in boiling glacial acetic acid it dissolves slowly. The tri-nitro (that is to say, mixtures rich in the tri-nitro) is gradually dissolved at an ordinary temperature in absolute alcohol; a great excess of ether produces a milky precipitate in a concentrated alcoholic ethereal solution. It is easily dissolved in acetic ether, wood spirit, and boiling glacial acetic acid.

By treatment with concentrated nitric and sulphuric acids both tetra and tri-nitro are changed into penta and hexa-nitro. Potassic lye and caustic ammonia change them into di-nitro; their behavior is generally analogous with that of the hexa-nitro.

The compound described should be the true tri-nitro cellulose, and should not be a mixture of tetra-nitro with di-nitro. The di-nitro has the characteristic property of shrinking together in milky turbidity in the alcoholic ethereal solution, and when but an extremely small quantity of it is commingled with the tetra-nitro it causes the collodion film to become turbid. If, therefore, a collodion film (upon glass) be obtained clear and blank from any pyroxyline whatever, no di-nitro can be present, even in small quantities. Of this I have convinced myself by direct experiment with pure di-nitro. The occurrence of compositions having nitrogenous contents approaching to that of the tri-nitro cannot, therefore, be ascribed to an admixture of di-nitro, but must be attributed to the presence of tri-nitro cellulose. I, therefore, consider the assumption of the existence of this compound to be well grounded, though I have not yet succeeded in isolating the substance.

DI-NITRO CELLULOSE, $C_{12}H_{12}O_4(NO_2)_2$, is always the last product of the nitric acid extracting action of potash or ammonia upon the other nitro celluloses, as well as of the action of very dilute, hot nitric and sulphuric acids upon cellulose when the pyroxyline has already begun—owing to partial decomposition, accompanied by the evolution of red fumes—to dissolve. If a solution of pyroxyline in a mixture of ether and alcohol be treated with potash or ammonia it gradually passes from the penta and tetra-nitro condition into tri-nitro, and, lastly, into di-nitro, which no longer gives off nitric acid, but by the continued action of the alkalis is decomposed, forms organic acids, and becomes resinous.

This reaction can be brought about in two ways:

A. The collodion is shaken up with a concentrated aqueous potassic lye; in a short time the fluid becomes brown, and a dark, tea-like alkaline fluid settles at the bottom. The ethereal alcoholic solution contains nothing more than can be precipitated by water. The aqueous alkaline solution is further diluted with water, slightly acidified by acetic acid, and a fine flaky precipitate is thrown out, which I purify by solution in a mixture of ether and alcohol, and obtain at last in the form of a yellowish-white, light powder. It contained 7.05 per cent. of nitrogen.

It is better to add the potash in alcoholic solution to the collodion, and after it has stood for about an hour to add a little water to the collodion, which has now become thin and fluid, and to separate out the di-nitro cellulose by acetic acid, as above, from the aqueous alkaline solution. In this way less of the tea-like by-product is formed.

B. I dissolved from two to four grammes of collodion cotton in 100 c.c. of alcohol and ether, added to the collodion from twice to three times the quantity of alcoholic potassic lye required for the neutralization of all the nitric acid, and shook up the whole. The collodion became very fluid and of a yellow-brown color. After an hour or two it was greatly diluted with water, and the free potash was neutralized by dilute sulphuric acid. A white flaky precipitate collected on the surface, which, when filtered off and dried, shrank up into a transparent yellowish mass (like silicic hydrate). If a sufficient excess of potash be not present during this operation a mixture of tri-nitro and di-nitro will be formed, which, according to my analysis, contains 8.49 per cent. of nitrogen (and therefore consists of about equal parts of tri and di-nitro). The collodion to which the alcoholic potash lye has been added can then be considerably precipitated (secretion of flaky pyroxyline) by much water, while after the full conversion into di-nitro water can produce but little precipitate.

The analyses of the triturated di-nitro cellulose dried in a vacuum over sulphuric acid gave—

	Computed.	Found.		
		A	B	C
C	34.78	35.73	—	—
H	4.34	4.60	—	—
N	6.76	—	6.89	7.05

Therefore di-nitro cellulose is the last product of the reaction, and in this view I agree with Wolfram, who also refutes Béchamp's statement that the tri-nitro is the last product of the reaction of potassium.

Di-nitro cellulose is, according to the way in which it is prepared, either a yellowish gum or a flaky powder. It is (like all precipitated pyroxyline) difficult of ignition, and explodes at 175° C. It is very soluble in a mixture of ether and alcohol, absolute alcohol, acetic acid, wood spirit, acetic ether, and acetone, but very difficult of solution in pure ether. In ethereal alcoholic potassic lye it is soluble, and also in the aqueous lye (when precipitated in the way mentioned above from potassic collodion); from these solutions it can only be precipitated by acids. Every time a great quantity of the di-nitro was destroyed at the solution in the potassic lye, and was converted into a blackish-brown, gummy mass. Its behavior in the ether and alcohol solution is characteristic: When evaporated on to a glass plate it leaves an opaque, milky-turbid, friable film of collodion; and even a slight admixture of di-nitro imparts the same property to a good collodion.

Wolfram has proved that by the reaction of gaseous ammonia with a solution of collodion cotton, in a mixture of ether and alcohol containing a little water, di-nitro cellulose is gradually formed.

I found that by shaking up collodion with solid potassium or sodium carbonate, in a few days potassium nitrate and cellulose di-nitro were formed, which combined in a striking manner with the potassium or sodium carbonate at the bottom of the bottle, so that the mixture of ether and alcohol no longer contained any pyroxyline. Acetic acid precipitated flaky cellulose di-nitro, having the already-mentioned properties, from the aqueous potash solution.

Apparently there exist compounds of di-nitro cellulose with alkalis, which are insoluble in the mixture of ether and alcohol, soluble in water, and are decomposed by acids with precipitation of di-nitro.

A MONO-NITRO CELLULOSE I have never obtained, as even by the continued reaction of potassic lye the di-nitro is destroyed before a mono-nitro forms. In the foregoing I have therefore described five cellulose nitros, namely:

Hexa-nitro cellulose,	(insoluble in mixture of ether and alcohol).
Penta-nitro cellulose,	(soluble in mixture of ether and alcohol).
Tetra-nitro cellulose,	
Tri-nitro cellulose,	
Di-nitro cellulose,	

The first-named compound is *gun-cotton* proper; the others, with ether and alcohol, give collodions, for which I propose to give them the generic name of "collodion pyroxyline." —Dr. Josef Maria Eder, in *Photo. Mittheil.*

NOTE ON SOME EFFECTS PRODUCED BY THE IMMERSION OF STEEL AND IRON WIRES IN ACIDULATED WATER.*

By PROFESSOR D. E. HUGHES.

DURING a discussion upon a very interesting paper by our President, "On the Durability of some Iron Wire," I mentioned a fact which I had lately observed, and which must have been observed by many others, viz., that steel or iron wires immersed for a few minutes in acidulated water, containing one-tenth sulphuric acid, became excessively brittle.

Our President has since kindly asked me to make a few more experiments on this subject, and to embody them in the form of the present note.

Upon repetition of these experiments, I have found that this brittleness is no mere accidental result, due to some flaw in the steel or iron wires, but that the resulting brittleness is invariable in all kinds of steel as well as iron. Nor is the effect due to any specific proportions of sulphuric acid to the water; nor, in fact, as we shall see later, to any particular acid. The effects, however, seem confined to steel and iron; as by similar treatment I have as yet obtained no perceptible effect on copper or brass.

At first I was inclined to believe that the effects were due primarily to a change in the molecular structure, but a more extended series of experiments has led me to adopt entirely the view taken by my friend, Mr. W. Chandler Roberts, who pointed out that the effects were most probably due to the absorption of hydrogen.

I have tested these wires in my induction balance, but can find no change whatever in their magnetic conductivity, nor any change which would be the equivalent of those produced by heat, strain, torsion, or tempering; but there are very evident results produced, if the conditions of the experiments are such as to favor the absorption of hydrogen. For instance, if we reduce the proportion of sulphuric acid to one-twentieth, we find that it requires some thirty minutes' immersion to produce the full effect, a few minutes' immersion producing no perceptible result. If, now, we place an amalgamated zinc plate in the same liquid and join the two extremities, we have an ordinary battery where hydrogen is given off on the steel wire. Now, as the production of the hydrogen by the decomposition of the water is much more rapid than before, we find that a few minutes' immersion produces a far more brittle wire than could be obtained by hours of simple immersion, and we have the result free from any doubt as to its being a mere surface action, for, if we immerse the wire alone, surface corrosion rapidly takes place, but by simply connecting it with the zinc the steel is perfectly protected, retaining its original bright surface for any time, as long as it is so protected.

It is not absolutely necessary that we should join the zinc in the same cell, for, if we pass a current from a few cells of an external battery through two steel wires as electrodes in sulphuric acid and water, we find that both wires have become brittle, though in a very different degree, the wire connected with the zinc or negative pole remaining bright, although excessively brittle, while the one connected with the positive pole is much corroded, and but feebly brittle, with this arrangement. I find that sulphuric acid is no longer required, but that all acids, neutral salts, and ordinary water, produce an active effect, the time required being simply inversely as the conductivity of the liquids employed. When water or most neutral salts are used, we find the negative pole quite bright but brittle, and the positive pole much corroded, but not at all changed as regards its flexibility.

I believe that these effects are due to the absorption of hydrogen when the hydrogen is in the "nascent" state, for I have obtained no results by the continued immersion of the wire in carburized hydrogen gas (ordinary lighting gas), but when placed into a medium containing the hydrogen just freed from its combination, its effects are most remarkable; for, if we immerse a wire into sulphuric acid and water, say one-twentieth, the effects are slow, requiring at least thirty minutes; but if we let fall into this water some scraps of zinc, hydrogen is rapidly given out, and by now immersing the steel wire in this gaseous liquid, taking care not to touch the zinc, we find that the steel becomes rapidly brittle, while its surface is free from corrosion, due, no doubt, to the protecting surface of the surrounding hydrogen.

Hydrogen seems to permeate through the entire mass, for iron rods three-quarters of an inch thick were equally affected, requiring more time, or, in other words, a supply of nascent hydrogen sufficient for the larger mass; and once the wire has become hydrogenized (if we may be allowed the expression), it retains it under all circumstances of time and change of surrounding atmosphere; heat alone, of all the means I have tried, has any power in removing this effect; and if we heat a wire to cherry-red in a spirit lamp, we find that it is completely restored to its primitive flexibility in a few seconds. This same wire, however, on being immersed in the acidulated water, rapidly becomes again brittle; we may thus at will render the same wire flexible by previously heating it, or render it exceedingly brittle by favoring its absorption of hydrogen.

I have remarked that a wire immersed in sulphuric acid

and water in any proportion, say one-sixteenth, becomes more electro-negative than at the first instant of plunging. If we take amalgamated zinc as the positive element, and a steel or iron rod or wire for negative, we find that there is such a remarkable similarity of electro-motive force between all kinds of steel and iron, that we are forced to the conclusion that we are simply testing the electro-negative qualities of hydrogenized iron; the force being with amalgamated zinc 0.56 volt.

I noticed here a remarkable fact, and which does not agree with the results of many authorities. I found that as soon as the iron rod had absorbed its maximum of hydrogen (a few seconds after being short-circuited), that it produced a constant cell, giving but small traces of polarization when or after being short-circuited for hours at a time. There occurs, however, slight diminution of electro-motive force after a few days' hard work, being then 0.32, due to the acidulated water becoming more neutral by the formation of sulphate of zinc and iron. If, however, we wish to restore its full electro-motive force, we have only to short-circuit the cell for a few seconds, torrents of hydrogen will be given off, and its electro-motive force becomes, on testing, of its highest value, 0.56.

If we short-circuit the hydrogenized iron cell for one minute, and at once test its electro-motive force, we shall find at the first instant a certain amount of polarization, about 10 per cent., but the cell rapidly recovers, being at its full initial force in ten seconds' repose; while cells with carbon, platinum, and all other negatives yet tried did not recover their polarization in one minute's repose.

Taking the Smee battery as the best example of depolarization in a single liquid, and comparing the constancy of this cell with that of the hydrogenized iron, I find that, according to Mr. Latimer Clark's experiments, in his work on electrical measurements, the electro-motive force of a Smee cell is 1.017, but when in action only 0.446. Thus its electro-motive force in action is less than that of the iron cell, and its polarization some five times greater than that of iron.

I have submitted these results (rather hastily obtained) to our President, Mr. W. H. Preece, and he has kindly consented to have some exact measurements made of the electro-motive force of the hydrogenized iron, and its comparative freedom from polarization with all other metals employed as negative elements in a single liquid cell, and I hope this evening we shall hear the results.

A practical application of iron as a negative may be mentioned. If we wish to purify mercury from any zinc, or any metal less negative than iron, we have only to place the mercury in dilute sulphuric acid, and then introduce an iron rod so that its lower portion shall make contact with the mercury, hydrogen is now freely and constantly given off by the iron, and this continues until all traces of zinc have disappeared; and as a proof of this, if, after a certain time, when no hydrogen is given off, we simply touch the mercury with zinc for an instant, the hydrogen at once reappears, and continues until this small portion of dissolved zinc has been separated from the mercury.

In order to render evident the remarkable depolarizing power of iron, we use in the same cell several negatives, such as carbon, platinum, silver, copper, and iron; and if we test these negatives separately for its initial electro-motive force, we shall find them all superior to iron; but if we join all the negatives together and short-circuit the whole with the zinc, iron alone will freely give off its hydrogen, while carbon will appear to be entirely inert, and if, after this short circuiting, we insulate or separate the different negatives, we shall find on testing them that they are all polarized, carbon being the most so, and iron comparatively quite free, and giving at the moment of insulation the highest electro-motive force.

In conclusion, I may add that, if hydrogen seems to be an enemy of iron and steel, rendering it brittle, on the other hand, it is perhaps its best friend in rendering it more negative, and, while under its entire influence, completely preserving it from oxidation or rust.

During the discussion which followed, Professor ABEL, C.B., said: I must confess to ignorance upon the question raised. Professor Hughes's observations have excited much interest in my mind, and their having only recently been made is a striking illustration of the blindness of workers. I myself was engaged years ago making a number of experiments on the immersion of short pieces of iron and steel wire in dilute acids, but it was for the purpose of studying the structure of the wires as bearing upon an important manufacturing question, and I confess that the particular effects which Mr. Hughes has described as being produced by such immersion escaped my notice altogether. I would like to ask Mr. Chandler Roberts if he has measured the volume of gas which he was enabled to separate from the iron in his experiment before it was treated with hydrogen.

MR. CHANDLER ROBERTS: The amount of natural gas varies from three to ten times a volume.

Professor ABEL: One would hardly imagine that the brittleness developed in the metal could be due simply to the absorption of the additional ten volumes of gas.

The absorption of hydrogen by iron and steel wires is very much less than in the case of palladium, where it amounts to about 200 times the volume of the metal. It appears to me that we can only conceive that the change in the physical character of the metal must be ascribable to some such action as hinted at by Mr. Roberts, i. e., some kind of molecular disturbance of the iron by the entrance of the gas into the mass. At present we are seeking for an explanation without any adequate or sound foundation to work upon. I can conceive that some such action as suggested may take place; we have instances of molecular changes in iron itself, which may be brought about by causes which must, I think, be regarded as less disturbing in their character than this entrance and exit of gases into and from the metal. One would like to hear what the views of one familiar not only with the scientific but also with practical aspects of these questions are. I know of no one more competent than Mr. Anderson to express an opinion on the cause of this physical peculiarity of iron, and I beg that the question may be transferred to him.

THE PRESIDENT: Before discussing the matter further, I may mention that Mr. Stroh has made some experiments with wire that may assist Mr. Anderson to form some opinion; therefore I will ask Mr. Stroh to kindly relate his experiments.

MR. STROH: When Professor Hughes first brought the question before the society I felt doubtful as to how far the brittleness penetrated the wire after immersion in acidulated water. I took a steel wire about one-eighth of an inch thick, and found that brittleness was produced after immersion in dilute sulphuric acid for about half a minute. I filed the surface, repolished the wire, and still found it to be brittle; and, after making the wire much thinner by repeating this

* A paper read before the Society of Telegraph Engineers, London, April, 1880. Since the reading of this paper two very valuable communications on this subject have been brought to the author's notice, entitled "On the Influence of Acids on Iron and Steel," by William H. Johnson, R. Sc. (*Manchester Literary and Philosophical Magazine*, March, 1880); "On the Action of Hydrogen and Acids on Iron and Steel," by the same author (*Proceedings of the Royal Society* No. 158, 1879). These papers clearly show that iron and steel are rendered brittle by acids, and that its tensile strength is also affected. Mr. W. H. Johnson's researches were partially anticipated by M. Cailliet, who, in 1868 (*Comptes Rendus*, Vol. Lxvii, No. 18, p. 847), describes the action of acids on iron and steel, their absorption of hydrogen, and their brittleness in consequence.

process, the brittleness continued, and there is no doubt that it is not superficial, but penetrates to the center of the wire.

I was anxious also to find out other evidences of change produced by similar immersion, but was unable to find anything beyond the brittleness.

At the suggestion of our worthy President, I tried experiments to ascertain the tensile strength of wire after immersion in acidulated water, and I found that in this respect wire remained unchanged as compared with its natural condition. I have tried iron, steel, hard-drawn wire, and annealed wire, but in all cases the ordinary tensile strength remained unaltered.

Heating restores the flexibility of wire so made brittle; but, of course, in the case of hard-drawn wire, the hardness is destroyed also.

Mr. ANDERSON: When the President invited me to attend this meeting and hear what Professor Hughes was going to say on the occlusion of hydrogen in iron and steel wire, I at once thought that I might hear something to my advantage, because I have the honor of presiding over the Committee of Research of the Institution of Mechanical Engineers on the hardening and tempering of steel. The question at present before that committee is the explanation of the hardening and tempering of steel; and the theory, for which I believe I am responsible, but which I think also finds favor with my colleagues, is that it is due to the greater or less quantity of hydrogen contained in the steel tending either to separate the particles or to allow them to approach more closely together. The experiments Professor Hughes has described confirm this theory, and show that the excessive occlusion of gases tends to separate the particles to such an extent as to make the steel more brittle. The application of heat again expels the gases and allows the metal to return to its normal state; but if suddenly quenched, so as to prevent the gases re-entering to some extent before the steel is cool, its particles are able to approach closer together, and therefore become more compact and render the steel harder. I should like to ask Professor Hughes whether, in the brittleness he has noticed in steel, he has found its hardness increased or otherwise?

Professor HUGHES: I have not been able to verify that fact.

The President: Mr. Stroh will perhaps answer.

Mr. STROH: I think I can safely say that the hardness of the steel is not affected in the least degree.

Mr. ANDERSON (continuing): When a theory has been started it is important to become acquainted with everything in the way of trustworthy experiment that may throw light on the subject. Professor Hughes's experiments show that the occlusion of hydrogen gas tends to separate the particles of steel, and this separation tends to reduce their cohesive power, according to the well-known laws of attraction. It is also known that hard steel carries a greater strain per square inch than the same steel softened, simply because the particles are very close together, and their cohesive force thereby increased. The first idea of this theory was suggested to my mind by Edison's experiments in searching for a permanent substance for his electric light produced by the incandescence of wire. He found that platinum felt to pieces, and propounded the theory that this was caused by the escape of occluded gases, causing cracks in the platinum and gradually destroying it. Edison argued that if, by repeatedly heating the platinum in vacuo, he could get all the gases out, he would then obtain a permanent material. He appears to have performed the experiment, and arrived at the result that an exceedingly hard and permanent substance was capable of being produced.

Professor ABEL: I think the case alluded to by Mr. Anderson does not quite correspond with that established by Professor Hughes's experiments, which show that iron wires may be made brittle and restored any number of times; whereas Edison's experiments appear to have soon brought platinum to a state of rest as regards the alteration of its molecular structure.

Professor HUGHES: Yes.

Professor ABEL (continuing): Another important point to bear in mind is that the increase in volume of gas absorbed is only about double that originally existing in the metal. Mr. Roberts finds about ten volumes of gas existing ordinarily in malleable iron; the maximum volume of hydrogen absorbed, and by which that gas is displaced, is therefore only double that original volume. Is it possible that the absorption of this additional volume of gas is sufficient to account for the supposed separation of the molecules and great change in the physical qualities of the metal?

It appears to me that there is still something wanting to explain the great change which the metal undergoes, and the restoration of its original properties for an indefinite number of times.

Professor HUGHES: During my experiments I continually kept in mind the theory advanced by Mr. Anderson, and as yet have found no experimental fact which could support it; on the contrary, I have remarked that tempered steel occludes hydrogen with as much, if not more, facility than soft steel, and does not become soft after having done so. I have not, however, made a special study of this point, but will do so at the earliest opportunity.

The action discovered is very peculiar in its behavior. There is no doubt that steel or iron becomes excessively brittle, and breaks off like glass and appears rotten, that it can be restored by heat and rendered brittle by acid many times. But the most curious fact is that if we take a wire, when brittle, and strain it, expecting it to break to pieces, it is almost as strong as before. This surprised me, and I tested the strained wire for brittleness, but found it had disappeared, and I concluded that the mere strain had had the effect of excluding the hydrogen. The departure of the hydrogen, of course, cannot be witnessed, but in practice the strain seems to rearrange the particles, and this molecular rearrangement seems to allow the hydrogen to escape.

Mr. VON TREUENFELD: The subject of the discussion is of very great importance in telegraphy, especially with regard to the question, "Is galvanizing injurious to telegraph wire or not?" I had an occasion of learning the injurious effect of galvanizing iron wire as far back as ten years ago, when constructing telegraph lines in South America. A large quantity of iron wire was ordered from England, which was tested before being galvanized by a competent inspector, and proved satisfactory in accordance with the government specification. It was afterward galvanized and shipped; but on its arrival in South America it was again tested, and failed to reach the given standard; after an investigation it was proved that it had suffered from exposure to acidulated water during the galvanizing process.

Professor HUGHES: I have listened with very great pleasure to the discussion on my paper, but I do not feel very clear yet as to the theory on the point. There is the certain fact that the iron wire absorbs hydrogen, and that the wire

becomes brittle, but the reason why has not yet been given. But one very extraordinary fact has come out. I have always understood, and have been taught to believe by most electrical works, that iron is one of the worst negatives that could be employed. Authors record iron as polarizing rapidly, and this error has been copied and repeated in electrical works until the statement has become one of common belief. Now, if iron absorbs hydrogen, and hydrogen is the cause of polarization, one would expect to find greater polarization in iron than in any other substance; but, to my surprise, when tested (as also stated by Mr. Kempe), it was less than any known substance, and after short-circuiting an iron and zinc element for hours it rises extremely rapidly again. Its constancy is higher than any other single liquid cell. In fact its constancy is so remarkable that it can only be compared with a Daniell. The resistance of this cell is also less than any other, exposing the same amount of surface—in a similar acid. When we measure the resistance of a single liquid cell we are really not measuring the resistance of the liquid at all; for every negative we put in, all being of similar dimensions, there is a different resistance to that liquid, and it is really the resistance of the negative element and its polarization that varies. My view of the matter at present is that iron absorbs hydrogen, and that being full of hydrogen, when hydrogen comes against it in the cell, it is repelled and given off in the streaming torrents of bubbles that are so astounding. Really the iron cell is worthy of being studied and investigated—as where large and constant currents are required, as in the case of electro-metallurgy, electric light, etc., it is the most simple and economical battery that we possess.

HYGROMETRIC PROPERTIES OF CHARCOAL.

We have perused recently an interesting paper by a French chemist, M. Jaillard, on the power of wood charcoal to absorb moisture, the results of which may be some day turned to practical account in many ways, and are at present interesting to manufacturers of gunpowder and fireworks compositions.

The author found that if wood charcoal were sprinkled with water and exposed to the air for three days, it underwent the same loss of weight by exposure to a temperature of 110° C. for two hours, as another sample did which had not been wetted.

It was next found that charcoals prepared from different kinds of wood, if exposed for a sufficient length of time to the same atmosphere, lost, when heated to 110° C., for two hours, from 9 to 10 per cent. of their weight, the humidity of the atmosphere at the time being found to be 80 per cent.

The practical conclusion drawn from these experiments is that different kinds of wood charcoal have nearly identical absorption power for moisture in the atmosphere. But the quantity of moisture thus absorbed varies with the degree of humidity of the atmosphere at the time of the experiment. According to M. Jaillard, this quantity is invariably from 9 to 10 per cent., when the quantity of moisture in the air is 80 per cent. of the total amount which the air can hold in solution or suspension. We trust that these results may be confirmed by future experiments; if so, they will throw considerable light upon many phenomena with which we are at present only very imperfectly acquainted.—*Monthly Magazine*.

ANALYSIS OF CHIAN TURPENTINE.*

By G. W. WIGNER, F.C.S.

CHIAN turpentine has for many years past been almost unknown in this country, and its use in pharmacy had almost entirely ceased, but special interest has been directed to it of late by the statement of the success with which Professor Clay has been using it in the treatment of cases of cancer. Great difficulty was experienced in obtaining even a small supply of the genuine article, and Professor Clay stated that more than 95 per cent. of the samples which he had seen were spurious. I have examined some samples of undoubted genuineness in order to obtain a standard for future comparison.

The description given in Flückiger and Hanbury's *Pharmacographia* is as follows: "A soft solid becoming brittle by exposure to the air; viewed in mass it appears opaque, and of a dull brown hue. If pressed, while warm, between two slips of glass, it is seen to be transparent, of a yellowish brown, and much contaminated by various impurities in a state of fine division. It has an agreeable, mild terebinthinous odor and very little taste."

As to its chemical composition, *Pharmacographia* says that it consists of resin and essential oil; the former, i.e., the resin, being probably identical with the alpha resin of mastic.

The first sample which I examined (obtained from Messrs. Allen & Hanbury's) was very probably a portion of the sample referred to in *Pharmacographia*, and would, in all probability, be 10 or 15 years old. It was of an opaque yellow brown color, rather too soft to make a good pill mass alone; very slightly sticky, and covered on the surface with a whitish powder, which appeared to consist of parts of the resin itself, acted on by the atmosphere. A small portion was melted and dropped into cold water so as to form tears, and the sp. gr. of these tears was found to be 1.030 at 60° F. If one of these fragments is gradually heated in water to the boiling point, it melts and expands rapidly, becoming lighter than the water, and floating as a film on the surface.

With the exception of a small amount of mineral impurities, consisting chiefly of sand, it dissolves readily in boiling alcohol 60 c.p., which becomes slightly milky when cold. The resin is precipitated as a white powder on dilution with water.

Absolute alcohol dissolves it readily even in the cold; so also do ether, chloroform, and bisulphide of carbon. Petroleum spirit and turpentine dissolve it readily on warming, and wood naphtha dissolves it slowly on warming, the solution becoming slightly milky on cooling.

A portion was distilled with water for the volatile oil, which was found to amount to a little over 9 per cent.

A 20 per cent. solution of the turpentine itself was examined in the polariscope, and gave a right-handed rotation of 9° 13' in a tube 200 mm. long for the sodium ray.

The essential oil from the same solution gave a rotation of 1° 54' for the sodium ray, leaving 7° 18' as the rotation due to the resinous constituents.

The sample contained two different resins, one of which saponifies readily with carbonate of soda, and the other saponifies with somewhat more difficulty, but forms a far less soluble soap. This latter is present in by far the larger

quantity, and it appears likely from its appearance and character that it corresponds pretty closely with the alpha resin of mastic.

Dividing these resins as far as possible by solubility, the sample appeared to contain as follows:

Volatile oil.....	9.2 per cent.
Alpha resin.....	79 "
Gamma resin.....	4 "
Benzoic acid.....	traces.
Impurities, chiefly sand.....	7.3 "
	99.3 "

The second sample I examined was a portion of a new supply just received in this country, but coming through almost the same channel as the first one. It was, of course, newer, and probably from that cause somewhat softer; the brittle characteristic of the original sample was, however, strongly marked, and the tears, which had been produced by letting a few drops fall into the water, were sufficiently brittle to break when allowed to fall on to the table.

A 20 per cent. solution, examined in the polariscope with a sodium flame gave a rotation of 7° 46', of which 1° 54' was due to the volatile oil, and the difference 5° 52' to the resin. Apparently, therefore, there was some slight difference in the optical rotatory power of the resin in this sample.

Saponified and treated in the same way, it gave the following results:

Volatile oil.....	9.2 per cent.
Alpha resin.....	81 "
Gamma resin.....	6 "
Benzoic acid.....	traces.
Impurities—ash.....	1.4 "
Woody fiber.....	2 "
	99.6 "

The sp. gr. of this sample was 1.032, or rather higher than the old one.

A third sample of very similar appearance was procured in London from another source. This was probably old, although, perhaps, not so old as the first sample above referred to.

The sp. gr. was 1.043. The rotation in the polariscope was practically identical with the first sample. The analysis showed, however, a larger percentage of volatile oil, viz., 12.1 per cent., and it contained a mere trace of ash and a smaller proportion of impurities. This, which was to all appearance a genuine sample, was evidently more carefully collected.

A fourth sample, also purchased from a London wholesale house, was obviously a spurious one, and I record its characteristics here simply to enable such samples to be distinguished. In color, appearance, and smell it closely resembled Canada balsam; it was softer and far more tenacious than genuine Chian turpentine, so sticky, in fact, that it was with difficulty it could be removed from the fingers. When a portion was rubbed on the hand the smell was extremely pungent and persistent. The sp. gr. was 1.000, or exactly identical with water at 60° F. In connection with this, it should be borne in mind that the sp. gr. of Canada balsam is less than water, some samples being as low as 970. Its rotatory power in the polariscope was 6° 15' for a 20 per cent. solution in a tube 200 m.m. long; that is, it was only about two-thirds of the rotation of the genuine samples. It yielded about 26 per cent. of volatile oil, or more than twice that contained in the genuine samples, and the rotation due to the volatile oil was 3° 36', leaving only 2° 39' due to the rotation of the resin, or less than half that of the genuine samples. The solubility in alcohol, ether, chloroform, petroleum spirit, naphtha, bisulphide of carbon, and turpentine showed no difference from the genuine samples which was capable of being used for discrimination. It appeared to contain about 70 per cent. of a resin which corresponded in some respects to the alpha resin found in the genuine samples, but was of a darker color, and formed a much harder and more brittle soap, while I could not detect the slightest trace of benzoic acid. My opinion is that this sample was mainly a mixture of colophony and Canada balsam.

It appears most probable that the Chian turpentine, described as Cyprian or Syrian, or Chio, in *Watts' Dictionary*, p. 920, was a sample of this kind, for the description there states, among other things, that it was viscid, and had an aromatic taste like that of mastic, both of which statements correspond exactly with this spurious sample, but are incorrect as regards the genuine samples first referred to.

NOTES ON CREAM OF TARTAR.*

By ALFRED H. ALLEN.

CRUDE tartar or argol is well known to be a crystalline crust deposited during the fermentation of grape juice. It consists largely of acid potassium tartrate, but if plaster be used in the manufacture of the wine, the tartar contains a large proportion of calcium tartrate.

Cream of tartar is generally admitted to be a preparation obtained by boiling crude tartar or argol with water, filtering, and crystallizing the salt from the clear liquid. The term "cream" of tartar is derived from the fact that during the evaporation of the liquid the salt is deposited in white crystalline crusts on the surface of the solution.

Cream of tartar thus obtained consists chiefly of potassium hydrogen tartrate, $\text{KHC}_4\text{H}_4\text{O}_6$. All commercial samples contain more or less tartrate of calcium, which, though nearly insoluble in pure water, dissolves with moderate facility in a hot solution of acid tartrate of potassium.

According to the *British Pharmacopoeia*, cream of tartar is a synonym for the acid tartrate of potash, but the solution in hydrochloric acid is admitted to be "rendered slightly turbid by oxalic acid" after neutralization by ammonia.

According to Pereira, cream of tartar "contains from two to five per cent." of calcium tartrate. All the specimens which Thomson examined contained "rather more than five per cent." Stillé and Maisch say "the amount of tartrate of calcium contained in crude tartar varies between 5 and 15 per cent."

According to R. Warington—a high authority on this subject—the proportion of tartaric acid existing as neutral tartrates in refined tartars varies from one and a half to seven per cent. Taking these amounts as calcium tartrate, we may say that the proportion of that salt existing in cream of tartar is, according to Warington, from 2 to 8.8 per cent.

In my capacity of public analyst, I have recently received from inspectors 14 samples of cream of tartar which have been considered genuine. These were obtained at various

* Read before the Society of Public Analysts, on 24 June, 1880.

* Read before the Society of Public Analysts, on 24th April, 1880.

small towns and villages in Derbyshire and the West Riding of Yorkshire, and their purchase extended over some ten months. As one of the tests of purity, I am in the habit of igniting a known weight of the sample, boiling the residue with water, filtering, and again igniting the residue. This last product, when moistened with carbonate of ammonium, consists essentially of calcium carbonate. If the original cream of tartar was pure, it should dissolve completely in hydrochloric acid, or leave merely a faint trace of residue. Evidently its weight represents the calcium in the original sample, and if the amount be multiplied by the factor, 1.88, we obtain a very fair estimate of the proportion of calcium tartrate originally existing in the sample. In the fourteen samples referred to, the highest percentage of "insoluble ash" ($=\text{CaCO}_3$) found was 6.46 per cent., the next being 6.36, and no other above 4.68. The lowest amount was 2.60, and the mean of the whole fourteen was exactly four per cent. Multiplying these numbers by 1.88 we find that the highest amount of tartrate of lime met with was 12.14 per cent., the lowest 4.89 per cent., and the average 7.53 per cent. In the case of the two samples yielding 6.46 and 6.36 per cent., of insoluble ash, I ascertained the amount of matter left on boiling the original sample with water, and found 3.15 and 3.35 per cent. respectively. These residues, insoluble in water, were soluble in hydrochloric acid, and, as far as my notes go, appear to have consisted of calcium tartrate. Hence, if 3.15 be subtracted from 12.14 per cent., we have a remnant of nine per cent. legitimately present as a soluble constituent of the cream of tartar.

The following table shows the proportions of calcium tartrate present in cream of tartar, according to different observers:

	Neutral Calcium Tartrate. $=\text{CaC}_2\text{H}_3\text{O}_6$
Pereira	2 to 5 per cent.
Thomson	5 to 6 "
Warrington	2 to 8.8 "
Vauquelin	5 to 7 "
Paul	1 to 10 or 12 per cent.
Allen	4.9 to 9 per cent.

In contradistinction to the above results, on September 24, 1879, at Chertsey Petty Sessions, Mr. William Hodgkinson, of Aldersgate street, when under examination as a witness for the defense of a druggist who had been prosecuted for selling cream of tartar obtained from Messrs. Hodgkinson & Co., is reported to have stated that:

1. "Cream of tartar was sent to this country from Spain and France, and came in a state that was known as argol."
2. "The article sent to Mr. Boyce (the defendant) was the very finest that could be obtained."
3. "Argol, or cream of tartar, was the natural product of the fermentation of the juice of the grape."
4. "It was impossible to have cream of tartar without tartrate of lime, and he was informed from the best authority that it was generally found in quantities from 10 to 20 per cent., and the lowest he had ever heard of was 7 per cent."
5. "He could not account for the very small amount of baryta being with the drug, but had seen it with cream of tartar before."

In the course of a correspondence in the *Pharmaceutical Journal*, which arose out of the above evidence, Dr. Redwood wrote: "The cream of tartar alluded to by Mr. Hodgkinson, was represented by the grinder as having been obtained by the delivery order for 'cream of tartar in its crude state,' which, of course, means the usual roughly crystallized cream of tartar, a very different thing from crude tartar or argol."

Here, then, we have a general consensus of opinion that cream of tartar contains a maximum amount of nine or ten per cent. of calcium tartrate, and is distinct from argol, while, on the other side, Mr. Hodgkinson stands alone with his evidence that cream of tartar and argol are identical, and that the former contains a very considerable proportion of calcium tartrate.

With a view of ascertaining by direct experiment how far calcium tartrate could exist normally in cream of tartar, I have instituted the following experiments:

Pure calcium tartrate was prepared by precipitating calcium chloride by neutral sodium tartrate prepared from pure tartaric acid and carbonate of sodium. The analysis of the salt showed that it was strictly neutral in composition.

Pure potassium hydrogen tartrate was prepared by dividing a solution of pure tartaric acid into two equal portions, neutralizing one with potassium carbonate, and adding the other.

Weighted quantities of the last product were dissolved in known measures of boiling water, an excess of moist tartrate of calcium added, the liquid boiled for a short time, filtered boiling hot, and the crystals of cream of tartar deposited on the cooling of the filtrate were analyzed. In this manner, products were obtained which contained as much calcium tartrate as would dissolve in the measure of boiling solution of tartrate of potassium employed. The only variable condition was the proportion of water used.

It was not found practicable to dissolve the acid tartrate of potassium in fifteen times its weight of boiling water. Hence 1 in 25 was the strongest solution employed. The following are the percentages of insoluble ash and anhydrous neutral tartrate of calcium contained in the different products:

Proportion of water used.	Insoluble Ash $\times 1.88 = \text{CaC}_2\text{H}_3\text{O}_6$.
1. 25 parts.	3.10 per cent. 5.82 per cent.
1A. 25 "	3.28 " 6.16 "
2. 50 "	3.40 " 6.39 "
2A. 50 "	3.30 " 6.20 "
3. 75 "	4.40 " 8.27 "
3A. 75 "	4.80 " 9.02 "

From these results, obtained in my laboratory by Mr. W. F. Cocker, it appears that the proportion of calcium tartrate contained in cream of tartar is greater the larger the proportion of water used for solution. The proportions of calcium tartrate are not always strictly constant even under apparently similar conditions. An additional experiment was made by evaporating, at a boiling temperature, a solution in 50 parts of water, and skimming off the crystals from the surface as fast as they formed. The product so obtained contained 6.8 per cent. of calcium tartrate.

The above experiments clearly show that, with such a

* Notwithstanding Mr. Hodgkinson's evidence, it is satisfactory to know that before the above case (selling cream of tartar containing 11.7 per cent. of tartrate of lime, and 6.6 per cent. of BaSO_4) was heard, his firm supplied to a Sheffield pharmacist a highly satisfactory article, containing barely seven per cent. of tartrate of calcium, and no trace of barium sulphate.

proportion of water as is likely to be used in practice, the product will not contain more than nine or ten per cent. of calcium tartrate, and this conclusion is fully confirmed by the general experience as to the composition of cream of tartar. One or two per cent. in excess of ten may be allowed as a margin, but it may be safely concluded that any sensibly greater proportion of calcium tartrate is not a normal constituent of the sample.

The higher amounts of calcium tartrate occasionally found in cream of tartar are, doubtless, due to adulteration by compounds of calcium. Sophistication by chloride of calcium is said to have occurred, and there are authentic cases of adulteration by chalk and marble. In a cream of tartar sold near Pontefract, I recently found 20 per cent. of sulphate of calcium* (anhydrous), probably added as plaster of Paris, and in a recent instance in America, as much as 75 per cent. of *terra alba* is reported to have been present.

I believe that in many cases in which a high percentage of calcium tartrate has been found, sulphates were also present, and hence the calcium tartrate did not exist wholly in that form in the sample, but was the result of a double decomposition on treating the cream of tartar with water.

In the sample in which I found 20 per cent. of calcium sulphate, there was also 2.3 per cent. of sulphate of barium. In a case at Huddersfield, Mr. Jarman found the same im-

as to make all the dust settle down to the bottom, almost all the sulphate of baryta will be found in this dust; in one instance that lately came within our knowledge the amount was no less than 45 per cent. There is, therefore, reason to believe that the adulteration of cream of tartar with heavy spar is systematically practiced, and that it is probably carried out by throwing a handful of the coarse powder here and there into the casks while they are being packed. A very probable origin of the sulphate of barium in ground cream of tartar is the objectionable trade practice of requiring the grinder to return ground material of the full weight of the article sent to him for reduction, thus compelling him to make up the inevitable loss of weight in some way.

ORGANISMS FOUND IN BEER AND WORT.*

By EMIL CHR. HANSEN.

RED-COLORED SACCHAROMYCES AND RED CELLS RESEMBLING SACCHAROMYCES.

In the course of my researches on the microscopic organisms of the air, I was fortunate enough, in July, 1878, to discover a red-colored saccharomycetes in one of the open flasks containing clear hopped-wort, which I had exposed to the direct action of the air under some cherry trees in the Carlsberg



ORGANISMS FOUND IN BEER AND WORT.

purity in the form of crystalline heavy-spar, and in many other cases small proportions of barium sulphate have been met with. Dr. Redwood suggests that the sulphate of barium may arise from the *gesso*, or Spanish earth, used for plastering wine. He appears to ignore the fact that barium sulphate is an insoluble body. Other apologists for its presence have suggested that it has its origin in the stones employed for grinding the drug. On this point I feel I cannot do better than quote an editorial which appeared in the *Pharmaceutical Journal* for November 22, 1879:

"The weight of cream of tartar ground by one pair of stones will sometimes amount to 15 or 20 tons in a month, and if only one per cent. of sulphate of baryta was introduced into the powder by the abrasion of the stones, they would very soon cease to exist as stones, since they do not weigh more than five or six hundredweight each. On the contrary, the fact is, that these stones wear down very little, and last a very long time. But there is another point of evidence especially conclusive as to the origin of the sulphate of baryta in cream of tartar, and this is the fact that by shaking a cask of cream of tartar crystals in such a manner

garden. From notes made immediately after the examination of this fungus, it appears that it does not differ except in color from *Saccharomycetes ellipsoideus*, and that in other respects it resembles the form described and represented by M. Brefeld under the name of "natural yeast (wine yeast or wild yeast)." A great number of cells had produced ascospores, and these did not differ in any material respect from the figures given by this author.

Red-colored cells of saccharomycetes are not mentioned by M. Rees, nor are they referred to in Pasteur's or Engel's works. MM. Schröter and Cohn communicated some observations on these organisms, which are described by the last-named naturalist under the title of "rose yeast," and ascribed to the species discovered by Fresenius—the *Cryptococcus glutinis*, but with the generic name of *saccharomycetes*.

On afterward examining the description and the drawings of M. Fresenius, I conceived some doubts as to the exactness of M. Cohn's conclusions; to clear up the matter, I instituted comparisons between my own results and those of these two savants, and I thus arrived at, besides numerous divergencies, many signs which proved that more than one species was included in the so-called *Cryptococcus glutinis*. But the question was still very obscure, and it was under these conditions

* This was calculated from the sulphates. The calcium was considerably in excess of that corresponding to the above amount of calcium sulphate.

† And how much silica would the cream of tartar contain?

* Translated specially for *The Brewers' Guardian*, by permission of the Carlsberg Laboratory.

that I made my first researches. It was necessary at first not only to obtain the red organism with its ascospores that I had previously observed, but also to find the forms described by MM. Fresenius and Schröter and Cohn. I repeated, therefore, their attempts to cultivate these organisms on gelatine paste and on slices of potato exposed to the air, partly in the laboratory and partly in a neighboring house; at the same time I placed flasks containing hopped wort in several places in the garden.

At the commencement of October one of the slices of potato, which had been kept moist, presented some rose-colored dry spots, so small that they could be scarcely distinguished with the naked eye. They were partly isolated and partly joined together in masses, in which case the beautiful rose-color was distinctly apparent. On examining them under the microscope I soon saw that they were formed of innumerable small saccharomyces, or at all events of forms which completely resembled this species. The cells were very small, and, as a rule, nearly spherical, and by their shape reminded me of the saccharomyces minor of Engel.

On the 5th October one of the flasks containing filtered hopped wort was opened in the garden, under some cherry trees. When I examined it on the 18th the liquid was still brown and rather clear, but it had on its surface some small patches of whitish fungi and some thin fragments of rose-colored membrane, composed mostly of oval cells, which resembled saccharomyces, and which contained, as a rule, very highly refractive granules; the deposit contained the same cells.

Toward the middle of the same month I observed similar rose spots on the gelatine paste which I had left in the laboratory for some days; they were formed of oval, colorless cells, the protoplasm of which was, as a rule, granular, and they contained in addition vacuoles and highly refractive granules. It is a very singular fact that some of the cells had developed buds like saccharomyces (Figs. 30, 31, 36), while others possessed long or short germinal tubes, often of the most fantastic shapes (Figs. 10, 19, 27, 29).

My experiments confirmed to a great extent the correctness of my views that these organisms develop only by buds when sown in beer wort, and by germinal tubes when sown on gelatine or plaster. To further prove the matter, I caused growths to take place in moist cells, taking as a substratum filtered hopped wort or boiled grape juice, gelatine, and pieces of plaster. The isolated cells were then observed for a long time at short intervals, and their development followed with care. As I expected, I observed that in fermentable liquids the cells only multiplied by budding (Figs. 1-3¹¹ and 35-35¹¹), and never developed germinal tubes. The cells thus produced were then sown, some on plaster, and others in a new nutritive medium formed of beer wort containing a small piece of perfectly transparent gelatine. At the expiration of three days, most of them commenced to put forth germinal tubes (Figs. 17, 18, 21), but the production was quicker and more certain on the plaster. Some of the cells thus observed, having been replaced in beer wort or grape juice, I noticed that not only the parent cells, but also in most cases the tubes, developed buds (Figs. 4, 7, 13, 15, 16). The red pigment was found both in the buds and the cells with germinal tubes. There is, therefore, no longer any doubt that the two forms belong to the same species, and that the budding and the development by tubes depend upon different external conditions.

The colored organisms which we have investigated can therefore multiply by budding in beer wort, and when sown on gelatine or slices of potato, produce beautiful rose and bright red spots. As long as they are of a pure red color, no bacteria are found with them, but as soon as the latter appear, a change in color is observed; they acquire a grayish or yellowish tint, and finally their beautiful red color disappears altogether. It is only when the cells are aggregated together in a mass that this color is manifest; examined in an isolated state under the microscope by transmitted light they are colorless, but by reflected light on a dark ground they have the appearance of whitish glass.

The results obtained may be summed up as follows:

1. Under the specific name of *Cryptococcus glutinis* Fres., are included several red-colored saccharomyces and red cells resembling this species.
2. Besides the form described by M. Cohn under the name of *Saccharomyces glutinis*, Fres., the present paper refers to two other forms, of which one develops ascospores like a true species of saccharomyces, and the other consists of cells resembling saccharomyces, which in a fermentable liquid such as beer wort or grape juice, behave morphologically like a saccharomyces and multiply by budding, while under conditions of insufficient nutrition they develop germinal tubes of diverse shapes.
3. The tubes, like the parent cell from which they issue, develop buds in a fermentable liquid.

EXPLANATION OF PLATE.

(The fractions indicate the magnifying powers used.)

Red-colored cells resembling *Saccharomyces* (Figs. 1-37).

1-3¹¹, 11¹¹, 11¹¹. Three series, illustrating the evolution of budding cells. The observations were made by examining isolated cells in a Ranvier chamber with air tubes, the nutritive medium being filtered hopped wort. 1. 1¹¹ hours; colony of cells where the parent cell has two short terminal tubes, each terminating in a point, and two vegetative points of which, the one at the top of the germinal tubes and the other at the opposite extremity, possess a spherical form; each of them has developed a small cell. 1¹¹, 2¹¹ hours; the upper cell has developed a bud, the first sign of which was visible after an hour and a half; the lower cell has increased in size. 1¹¹, 3¹¹ hours; the last-named cell is now detached from the parent cell; the parent cell has returned to the same phase as at the commencement of the observations; the young cell of the germinal tube is the same, and its fully developed bud has detached itself. 2; 1¹¹ hours; an oval cell with a short pointed germinal tube, which has developed a small bud on the top. 2¹¹, 2¹¹ hours; the bud has increased in size. 2¹¹, 3 hours; it is just about to detach itself. 2¹¹, 3¹¹ hours; repetition of phase 2. Buds having the same form and the same evolution continued to develop for twenty-four hours after the other; it took from one and a half to three hours from the time when the bud first appeared to the time when it had become a complete cell; it was then pushed on one side by a new bud, and became detached; thus in twelve hours five new cells were produced. 3. 2¹¹ hours; cell with a short and thick germinal tube which is split, and terminates in two points. 3¹¹, 3 hours; a bud is developing upon one of these tubes. 3¹¹, 3¹¹ hours; the evolution of this bud proceeds. 3¹¹, 4¹¹ hours; the newly-formed cell has freed itself, and the parent cell returns to phase 3.

4-7. Cells which have not only developed germinal tubes, but are also in course of multiplication by budding. To obtain these forms cells must be sown in a fermentable

liquid, such as beer wort or grape juice, after having been cultivated on plaster, according to Engel's method, until the germinal tubes have appeared. In Fig. 7 all the protoplasm of the parent-cell has passed through the germinal tube into the newly-formed bud.

8-29. Cells of a very varied appearance, the germinal tubes of which present different forms of development. In Fig. 8 we notice a cell the protoplasm of which has passed into the extremity of the germinal tube. Fig. 11 represents a cell resulting from prolonged growth upon the plaster; the germinal tube is split at the top and contains a partition. Fig. 13 offers an example of a germinal tube with a bud developing underneath. In Fig. 14 the germinal tube is swollen in the form of a bud at its center. Figs. 17 and 18 are distinguished by their germinal tubes; the latter has two, one of which is very pointed. Fig. 20 represents a cell with two germinal tubes, one of them being split. Fig. 26 illustrates long and branched germinal tubes which are produced by prolonged growth upon plaster. Fig. 29 represents a cell which has developed not only a bud, but also three germinal tubes, of which one is branched.

30-31. Budding cells.

32. Cell with a germinal tube, which at its very thick base has developed branches.

33. Oval cell, the germinal tube of which carries a large bud, which develops a short and pointed germinal tube. The parent cell and the bud both contain vacuoles, and the latter contains besides a very highly refractive granule.

34. Oval cell which has put forth not only a rather long and pointed germinal tube, but also a bud; the whole is filled with granular protoplasm.

35-35¹¹. Budding cell; one evolution; grown in a Ranvier cell, with filtered hopped wort as the nutritive medium; 35, 10¹¹ hours; 35¹¹, 11 hours; 35¹¹, 11¹¹ hours; 35¹¹, 12¹¹ hours.

36. Large and small cells, some of them budding.

37. Group of cells, in which one is just developing a bud; several contain highly refractive granules.

Red-colored *Saccharomyces* collected from under cherry trees. (Figs. 38-41.)

38-38¹¹. Budding cell in filtered hopped wort, cultivated in the Ranvier cell. 38, 2¹¹ hours; 38¹¹, 5 hours.

39-39¹¹. Budding cell; same growth as the preceding; 39, 8¹¹ hours; 39¹¹, 9 hours.

40. Colony of cells.

41. Cells arising from a growth on plaster. In consequence of the insufficient supply of nutriment, highly refractive spheroidal bodies have formed in their interiors; they are soluble in absolute ether, and may be considered as fatty substances.

Saccharomyces glutinis (Fres.) Cohn. (Figs. 42-44.)

42-42¹¹. Budding cell in filtered hopped wort cultivated in a Ranvier cell. 42, at ten o'clock; 42¹¹, at half-past eleven; 42¹¹, at a quarter past one; 42¹¹, at a quarter to two.

43-43¹¹. Similar growth. 43, At half-past eleven, a parent cell, with two young cells. 43¹¹, At a quarter past one; the cell on the left hand has detached itself and at the same time has put forth a bud; the other cell has slightly increased in size. 43¹¹, at two o'clock; the second cell has also detached itself from the parent cell, which is already commencing to develop a new bud.

44. Budding cell arising from a growth on plaster. The parent cell contains a large vacuole, and in the surrounding protoplasm is a highly refractive granule; the bud contains the same.

Micrococcus.

Sarcina.

46. In some cases, the groups are only composed of three or two spherical bodies; *a* represents a group which contains six, and *b* a group which contains the normal number, but where the two spherical bodies have been somewhat separated from each by the pressure of the glass covering plate.

Micrococcus (Torula form.).

47. Pear-shaped Bacterium. Figs. 48-49.

48. These cells are motionless, and always joined together in pairs. It is possible that I have here detected a new species; it was formed in a mucilaginous yellowish gray membrane on the surface of a hopped wort which had remained in the laboratory for two days.

49. Chain belonging no doubt to the preceding species; it, however, resembles externally the figure of *Bacterium lineola*, as given by Warming, but it is much smaller, and does not contain the granular matter which is so characteristic of the last-named species. I found this in Carlsberg lager beer which had been kept in the thermostat for thirteen days at 20-23° C. (68°-73° F.).

Microbacteria. Figs. 50-52¹¹.

50. These bear resemblance, in some respects, to very small specimens of *Mycoderma*, but they do not form into chains like the latter.

51. An evolution. The specimens here represented were cultivated in a Ranvier cell with air tubes, with filtered hopped wort as the nutritive medium. At first they somewhat increased in size, Fig. 53; an hour and a half later, two of the cells separated from the others, Fig. 52¹¹; a quarter of an hour after, each of the cells thus detached not only became enlarged, but was also itself divided in two, Fig. 52¹¹. These divisions were repeated, so that after a few hours a considerable number of bacteria were produced. This species can, according to my observations, decolorize wort and Carlsberg lager beer, which by its action lose their fine brown color and become yellowish and turbid.

Fusiform Bacterium.

53. *Bacterium Kochii*.

54. *a* represents an example where the cell is about to divide; the cell walls are equally distinct as in the others, and I imagine they all belong to the same species. This bacterium is motionless, and was detected in considerable numbers on the surface of white Copenhagen beer which had remained for fourteen days in the thermostat at about 5° C. (41° F.).

Bacterium Carlsbergense (new species).

55. These cells are oval or elliptical, and colorless with a rather bright spot at each end; they occur either isolated or joined together in chaplets. I observed no movement with them. This is a new species which I detected amongst the fragments of membrane on the surface of a hopped wort in a Pasteur flask which had been kept for about ten days in the thermostat at about 32° C. (90° F.).

Spirillum tenue. (Figs. 56, 57).

56. This figure only represents fragments of this species; many of them present the shape of a horse-shoe, and Figs. *a* and *b* offer examples of transverse division.

Bacillus subtilis. Figs. 58, 59.

58. Fig. *a* represents some specimens with spores, and Fig. *b* a germinating spore.

59. Long thread twisted into rings.

Mycoderma aceti (Kützinger), Pasteur and *Mycoderma Pasteurianum*. (New species, Figs. 60, 70).

60. Short and long chains of *Mycoderma Pasteurianum*. *a* is an example of a chain formed of highly refractive cells, which is terminated in a thread somewhat curved and slightly swollen; *b* represents a chain composed of four cells, the largest of which in the center is just about to divide; the other three, of more recent formation, have not yet become elongated. The figures are drawn from a preparation, colored blue by means of iodine.

61. Two chains of *Mycoderma Pasteurianum*, colored blue by iodine.

62. Separate cells of the same species.

63. Cells relatively large, the walls of which are very distinct.

64. Thread-shaped and fusiform phases of the two species of *Mycoderma*, in which may be seen the strange shapes which these organisms appear. In *a* a tube is partly divided into sections, and terminates in a body relatively long; *b* represents two spindle-shaped bodies; *c* a portion of the thread just about to divide; *d* is the same but very irregular in its appearance; *e* represents a portion of a chain which terminates in a large club-shaped body; *f* is a similar body which has become detached. In *g* is represented a thread very much swollen in parts and containing granular protoplasm; the thread *h* is swollen at its two ends, but divided in the center; at *i* are two threads which in the greater part of their length are divided into bodies of very various shapes and sizes; *j* represents a chain composed of irregular bodies, some pear-shaped, and arising from the breaking up of a thread; *k* and *l* are fragments of the same chain. I have good reasons for considering all the forms represented in Fig. 64 as belonging to the same species as typical chains of *Mycoderma*.

The figures *e*, *f*, *g*, *h*, and others not indicated by a letter are very strongly magnified; for the remainder I have employed a magnifying power equal to 1180.

65. Very highly magnified; chain of which the lower links have only recently been divided, and consequently are still almost spherical; the upper links have commenced to contract in the middle.

66. Short chain, in which the two bodies in the center each contain a highly refractive spore.

67. Chain of *Mycoderma Pasteurianum*, composed of four bodies just about to divide. The growth took place in a moist cell provided with air tubes, with Carlsberg lager beer as the nutritive medium, but before sowing the cells they were dried for a few seconds on the glass covering plate, so as to render the observation easier. 67, Four o'clock; the four cells are in a straight line and have only commenced to contract slightly in the center. 67¹¹, Half-past eight; the contraction has not proceeded, but the cells have lengthened and have changed their relative positions. 67¹¹, Eleven o'clock; three cells have divided, but the fourth has not undergone any change.

68. 68¹¹. Evolution similar to the preceding, and with the same treatment.

69. 69¹¹. Evolution analogous to the two preceding examples.

70. Very highly magnified. Abnormal chain composed of a variety of different shaped bodies.

71. *a* represents forms observed in porter, and *b* those in white beer.

INDIAN CORN.

By LOUISE REED STOWELL, Microscopical Laboratory, University of Michigan.

INDIAN CORN, or maize, is one of the most common adulterations of wheat flour. The name corn is frequently applied to the fruit of all the cereals, and so it was used when mention was made of corn in the Bible and in Roman history, while Indian corn was known only after the discovery of America. The botanical name is *Zea mays*, and belongs to the family of *Gramineae*. It is a native of tropical America, although it grows in the greatest abundance through the whole continent. It is found in its wild state in Paraguay and Chili. The cultivation of maize has within the last century increased to an enormous extent over the American Continent and throughout the most part of Asia, Africa, and Southern Europe. In the United States in 1870 there were raised 760,944,549 bushels of corn. It requires so little labor for its production, that it is among the most popular and cheapest grains cultivated, and consequently is produced by the poorer people of almost every country.

It is a most beautiful plant, and were it not so common it would be cultivated as an ornamental plant for the lawn and the flower garden. There are many different varieties of the foliage, some with broad leaves thrown off from a tall and stately plant, while others are dwarfs, growing only a foot or a foot and a half high with beautifully striped leaves.

Some writers have claimed great antiquity and an Eastern origin for maize; while others and able botanists have disagreed with them strongly. M. de Condolle says: "Maize is of American origin, and was not introduced into the Old World until after the discovery of the New. It was found to be cultivated by the aborigines from New England to Chili." The poet Barlow has said the same, though in a different way:

"Assist me first with pious toil to trace
Through wrecks of time thy lineage and thy race;
Declare what lovely squaw, in days of yore
(Ere great Columbus sought thy native shore),
First gave thee to the world; the works of fame
Have lived indeed, but lived without a name."

Varieties not now in cultivation have been found in tombs of an antiquity greater than that of the Incas; and Darwin discovered "heads of maize embedded in a beach which had been upraised at least 85 feet above the level of the sea."

Recent analyses show the following percentage of nutritive principles, as made by Dr. Dana:

Starch oil, sugar, and zeline.....	77.00
Nitrogenous matter, albumen.....	13.00
Water.....	9.00
Salt.....	1.31
	100.00

The ash contains a large proportion of phosphoric acid in combination with lime and other bases. The amount of fatty matter or oil is notable, varying with the kind of corn from six to eleven per cent. The hard flinty kinds of corn have the most, and the starchy kinds the least, oil.

Wheat contains about one and a half per cent. of fatty matter. Its only objection seems to be a deficiency of gluten or of nitrogenous substances as compared with wheat, for there seems to be no glutinous residue left when washed with water as there is in wheat. It is said by Gorham, to contain a reddish nitrogenous substance, to which he has given the name *Zeine*.

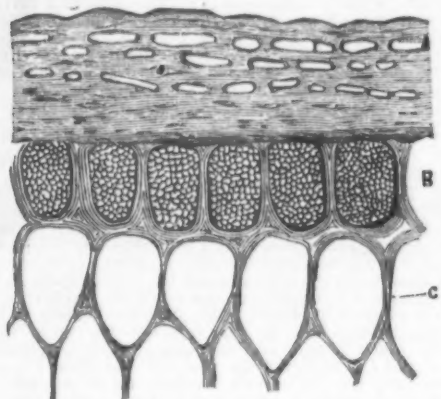


FIG. 3.—CROSS SECTION OF A KERNEL OF INDIAN CORN. Magnified 350 Diameters. Drawn with Camera Lucida.

The testa of the kernel of Indian corn, or the fruit and seed-coats, are reduced to two only. The epidermis, or outer coat, consists of one row of longitudinally elongated, tubular cells, where the thick, coarsely dotted wall is noted for the bearded appearance of its margin. See Fig. 4. The inner coat is composed of six or seven layers of parenchymatous cells, all running in one direction, and about three times as long as broad, having very strong walls. They are seen only in shadowy outline in Fig. 4. The outer layer of the albumen consists simply of one row of cells; thick-walled, nearly square, and loaded with albuminoids. In Fig. 5 we see these cells as they have been cut off from the kernel parallel with the outside. While in Fig. 3, b, we

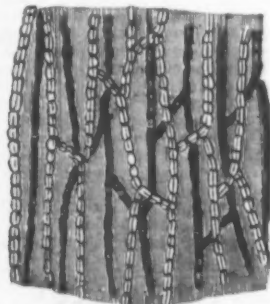


FIG. 4.—OUTER COAT OF KERNEL OF INDIAN CORN. Magnified 300 Diameters.

see them on a cross section. These cells are very similar to the albuminous cells of all the cereals as well as many other seeds. The central part of the kernel is composed of large thin-walled cells loaded with starch. See c, Fig. 3. A large white embryo occupies the whole of the lower part of kernel.

The starch grains of corn (see Fig. 6), are generally bounded by plane faces and angles instead of curved faces, as in wheat and potato. There are no rings and no indications of any present. There is quite a depression at the center of each of the faces. This depression is quite common in the starches of oat, rice and buckwheat, as well as corn. In the process of drying, the center of the grain or the nucleus

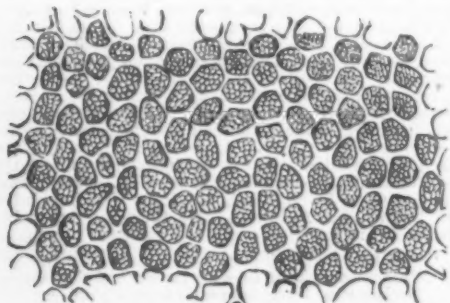


FIG. 5.—OUTER LAYER OF CELLS FILLED WITH ALBUMEN. Magnified 300 Diameters.

shrivels up in a peculiar and characteristic manner, which gives the appearance of stars or crosses on each of the faces, though it is sometimes only a little black spot. In fresh grains of corn-starch this central depression, together with the disk shape of some of the grains, gives them a general resemblance to the blood disks of the mammalia, according to Hassell. The depressions are due to the evaporation of more moisture from the center of the grain than from any other portion. The starch grains developed in the outer part of the kernel of corn are much more angular than are those of the central part. The angular appearance of these

grains is due to the way in which they are packed in the cells, each accommodating himself to his neighbor. So they look when taken out as soft pills would look were a number packed together in a small place. They are without a definite shape and yet all having the same general appearance. They are never found forming definite compound bodies as in the oat and buckwheat, as we will see later.

The starch grains of Indian corn average about $\frac{1}{16}$ of an inch in diameter, and there is quite a uniformity of size among the different grains as compared with the starch grains of potato.

When these starch grains are examined under polarized light well defined crosses are seen, the arms of the cross radiating from the nucleus at the center of the grain instead

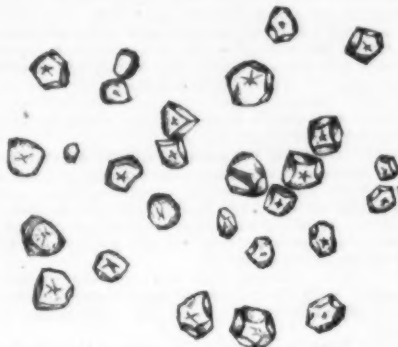


FIG. 6.—GRAINS OF CORN STARCH. Drawn with Camera Lucida. Magnified 475 Diameters.

of from one side, as in the potato starch. When subjected to dry heat the shape of the grain is but little changed, while if subjected to moist heat the shape is entirely destroyed. A solution of iodine turns the starch grains to a lighter blue, and potassic hydrate expands them like boiling water. The starch separated from all other constituents of the grain forms an important article of diet, which is sold under the name of "corn flour," while "corn starch" is proverbial for its laundrying properties.

It is estimated that maize is eaten by a greater number of human beings than any other grain, excepting rice. Its analysis shows it to be admirably adapted to sustain life, and to furnish material for the growth of both human beings and domestic animals. For maize is a highly concentrated nutriment, and is capable of serving, as it does in some tropical countries, as almost the sole food of the population. It is a most common article of diet with all Americans, and, on account of its cheapness, it is within the reach of the poorest. It has been estimated that, if cooked in the right way, a meal can be made from corn costing only one-half a cent a person. In the Southern States it constitutes a primary article of food, for rich as well as poor, old as well as young. In all of its various combinations, it belongs to the table as do the dishes themselves. It enters into the dietary of many of our public institutions and charities. Although it is used to such an extent among the farming population, it is little used in the cities, except as a relish. As "green corn," the supply furnished to the cities is perfectly enormous. Perhaps there is no article of food which is capable of being served in such a great variety of ways as corn. Hominy, boiled corn, pop-corn, corn meal, while hasty pudding is far from being the least, and whose praises were sung in verse:

"Some tawny Ceres, goddess of her days,
First learn'd, with stones, to crack the well-dry'd maize;
Through the rough sieve to shake the golden show'r,
In boiling water stir the yellow flour—
The yellow flour, bestrew'd and stir'd with haste,
Swells in the flood, and thickens to a paste,
Then puffs and wallows, rises to the brim,
Drinks the dry knobs that on the surface swim;
The knobs at last the busy ladle breaks,
And the whole mass its true consistence takes.
Thy name is *Hasty Pudding*! thus our sires
Were wont to greet thee fuming from their fires;
And while they argued in thy just defense,
With logic clear they thus explain'd the sense:
In *haste* the boiling cauldron o'er the blaze,
Receives the cooks the ready powdered maize;
In *haste* 'tis served, and then in equal *haste*,
With cooling milk, we make the sweet repast.
No carving to be done, no knife to grate
The tender ear, and wound the stony plate,
But the smooth spoon, just fitted to the lip,
And taught with art the yielding mass to dip,
By frequent journeys to the bowl well stor'd,
Performs the *hasty* honors of the board."

Corn is used as fuel in many localities, upon prairie farms, where wood and coal are expensive; while corn-cobs are a favorite for kindling wood on most every farm. Many smokers like a pipe where the bowl is made from a corn cob. Then the stalks and the leaves are of great value as cattle fodder, while corn is often sown for the sake of fodder only. The leaves of this plant have been manufactured into paper. An Austrian, Von Welsbach, invented a process by which the fibers of the stalk, leaves, and husks could be converted into paper. The juice of the stalk, before the grain ripens, has been converted into sugar and sirup, although it cannot compete with sorghum; so, indirectly, alcohol and whisky are produced from the plant. The oil is in such large quantities that it has been utilized for illuminating purposes. It is so very expensive extracting the oil, that it probably never will have general use as an illuminator. The leaves are used for upholstering purposes, husk mattresses being quite common. The more delicate leaves of corn are plaited into fancy articles, and we have from these braids, matting, slippers, hats, horse collars, etc.

In those unaccustomed to its use, maize is considered to excite and to keep up a tendency to diarrhea, but otherwise considered very healthy.

Indian corn is met with, in the state of a coarse flour in the shops, under the name of "polenta." It is frequently mixed with a pure quality of wheat, and sold under the name of "wheat," or "amylum." Even if it were as

palatable and more nutritious than wheat flour, yet a substitution always deserves the greatest condemnation.

Corn flour appears also in market under the name of *maizena*, *malzone*, etc. Recently the writer was called on to examine some so-called "baby food" that sold for seventy-five cents a pound. It was imported from France, and claimed to be made from the finest wheat flour. On examination it was found to be only corn starch.

Notwithstanding the fact that corn is so common, and even cheap, even this is subjected to adulterations. The most common substances used are beans, peas, oats, buckwheat, potatoes, and the other ingredients which have already been mentioned as forming a part of wheat flour.

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